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ABSTRACT

This book provides a total "how-to" approach for the use of technology, including information on the types of systems, hardware, and software available. It offers guidelines for determining how to match specific systems and needs, as well as strategies for implementing technology and Total Quality Education (TQE) to improve teaching. It also looks at developing the support necessary for the implementation of technology by using Total Quality Management approaches, which are labeled Total Quality Education in this application. The first three chapters set the background for developing a TQE method of thought and problem solving, developing the concept of an education as the product of schools and learning as the process. Suggestions for helping instructional managers change classroom practices and helping teachers apply TQE and technology are provided. Chapters 4 and 5 offer information regarding particular technological solutions. The specific systems, hardware, and software are defined, and tips for purchasing, implementing, and sustaining the systems are presented. Chapters 6 and 7 focus on the support necessary for success, including training, technical support, and maintenance. The eighth chapter challenges the educator to think about the future and what more schools and teachers could become. Chapter 9 provides some checklists, and chapter 10 offers thoughts to guide good decision making. Key terms and concepts end each chapter. Fifteen figures are included. (LMI)

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The authors dedicate this series to the memory of W. Edwards Deming, 1900-1993

TQE, Technology, and Teaching

Eugene R. Hertzke
Warren E. Olson

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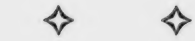

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Foreword

For decades, technology has been touted as the means for making major improvements in American education. Although the lackluster success of many projects has failed to support these claims, some have delivered in spades. Central Kitsap School District is a prime example. This book is not only a "must read" for school administrators, teachers, facility planners, and school boards, it is a manual the readers will want to use over and over to plan and implement technology in their schools.

The authors are Eugene R. Hertzke and Warren E. Olson. Dr. Hertzke has served the education profession as teacher, principal, assistant superintendent, and most recently as superintendent of the Central Kitsap School District since 1978. During his term as superintendent, Dr. Hertzke designed and implemented major technological advances to improve student achievement and teaching. He has published many articles in professional journals and serves as a technology consultant to many school districts and associations. Mr. Warren E. Olson has served as teacher, high school vice principal, director of secondary education, and administrative assistant to the superintendent in Central Kitsap. He and Dr. Hertzke have worked closely to implement technology and Total Quality Management (TQM) principles in Central Kitsap. He has published many articles and serves as a consultant on TQM and personnel training issues.

The authors' leadership in the Central Kitsap School District has resulted in many awards for excellence including the highly esteemed National Education Association's (NEA) Excellence in

Action. Their technology programs have been published in *Phi Delta Kappa, Equity and Choice*, and *Education Week* and have been featured in reports in *Business Week* and in the American Association of Social Administrators' (AASA) video production, "Systemic Leadership for a New Era."

TQE, Technology, and Teaching is a book for practitioners who envision major advancements in education. The advancements addressed in this book break conventional paradigms of instruction and management, and clear, concise steps show the way to achieve new paradigms. The authors make it clear that technology by itself does not work miracles, only people can do that. They illustrate techniques for working successfully with educators at the grass roots level, parents, businesses, and community organizations to design and implement technology. Techniques are discussed for training, for envisioning new paradigms, and for designing technology into buildings and for maintaining it. From the start, readers will recognize that this book was written by people in the schools, not by theorists and philosophers.

This book, with its many charts and checklists, tells how to achieve technological advances for improving learning and management. Further, readers will find techniques for advancing the paradigms of this book into bold new frontiers for improving instruction.

Larry E. Frase
San Diego State University

Preface

Personalized instruction, the Holy Grail of education, has remained elusive to educators for years. The difficulty of managing the information and designing the instruction for each child presents a formidable barrier to the classroom teacher. At the same time, the demands for inclusion of more topics in the curriculum and the changing characteristics of the students make obtaining progress in the educational system even more frustrating.

In many ways the system has reached its limits. There is little capacity left. However, one teacher, 180 days, 6 hours a day, and 30 children can only accomplish so much, unless one adopts fundamentally different ways of educating. As with many other businesses, technology holds promise for breaking through these limits. Combined with the philosophies of total quality management applied to education, more and qualitatively different outcomes can be achieved.

The opportunities to restructure schools with technology are immense, but the pitfalls are great. The experience of educators in the Central Kitsap School District forms the basis for this book. It began 8 years ago with the arrival of the first integrated learning system to the school district and the beginning of questioning how to change, why to change, and how much to change. People took risks. Most paid off. Lessons were learned and built on. It seems only proper to share those insights with other educators who want the best for their students and are willing to shatter paradigms to get it.

Most schools are examining technology and trying to determine how it can best be used. Some teachers receive it and do not understand why it was selected. Conversely, other teachers are begging for technology and do not understand the resistance to implementing it. This book looks at developing the support necessary for the implementation of technology by using total quality management approaches. Here we have labeled it a *Total Quality Education approach* and provided some definition of what that means for educators.

The book was prepared with the building-level administrator in mind. This is the person responsible for leading teachers and the one who needs the most "how-to-do-it" support. The book has many messages of interest to central office personnel and to teachers who wonder what the future holds for them. A central theme is the systemic nature of education and the schools. No book could effectively talk to only one group in a system and expect successful systemwide change.

Any group expecting to implement Total Quality Education or to implement technology into the instructional program should benefit from both the discussion of approach and the concrete advice about pitfalls and successful structures for technology.

Based on experience, the book is practical and, where possible, complete with step-by-step advice. It is not designed to be technical and detailed with an exhaustive discussion of specific attributes of one system versus another. Rather, it emphasizes the importance of each school or district determining its own needs and seeking the best processes to fulfill them. Technology is discussed as a management tool in addition to being a major component of an instructional program. Experience with particular configurations or systems is shared to help administrators and teachers evaluate these in light of their own situation.

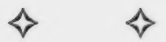
The first three chapters set the background for developing a Total Quality Education method of thought and problem solving. They develop the concept of "an education" as the product of schools and learning as the process. Customers inside and outside the institution are identified and used to define quality. It is in that context that technology makes sense as a tool to solve problems.

Chapters 4 and 5 offer information regarding particular technological solutions. The specific systems, hardware, and software are defined and considered based on the kind of problems that need to be solved. Experience with problems in purchasing, implementing, and sustaining the systems are examined, as well as questions of quantity and quality.

Chapters 6 and 7 focus on the support necessary for success. Technology is not a miracle device. Training issues, technical support, and potential maintenance problems and solutions are considered. Chapter 8 challenges the educator to think about the future and what it may mean for how schools are built, function, and succeed. The introduction of technology is an invitation to dream about what more schools and teachers can become. Chapter 9 provides some simple checklists, and chapter 10 offers thoughts to guide good decision making.

The authors are indebted to the Board of Directors, teachers, staff, and administrative colleagues in the Central Kitsap School District. Without the substantial risk taking, effort, and just plain hard work required for innovation, the dreams and experiences described in this book would not be a reality. Special recognition is due to Steven Anderson, Principal at Cougar Valley Elementary, and B. J. Wise, Principal at Silver Ridge Elementary, and their excellent staffs for their pioneering efforts with change and technology. Ron Gillespie, coordinator of Strategy 2020, and Jeannie Harmon, coordinator for staff development, provided much of the theory, practice, and training necessary for the success of the efforts.

Eugene R. Hertzke
Warren E. Olson
Central Kitsap School District



About the Authors

Eugene R. Hertzke recently completed 39 years in public education. Twenty-three of those years have been in the superintendency; the last 15 in Central Kitsap School District, Silverdale, Washington. He completed his master's at the University of Northern Colorado and his doctorate at the University of Colorado.

He has published numerous articles on the change process, the use of technology, and the decision-making process. He has received national recognition for leading the Central Kitsap School District through the process of restructuring and the rapid expansion of the use of technology.

He has served as a speaker and/or consultant for numerous state and national conferences. He keynoted at four international-technology-in-education conferences, appeared as an expert on four "how-to-do-it" videotapes, and was spotlighted by *The School Administrator* and *Education Week* as a pioneer innovator in the field of instructional technology. He has also served on the Advisory Board for *Electronic Learning* magazine.

Warren E. Olson currently maintains a consulting business, Strategic Services, which assists organizations with developing cost-effective training and process-improvement solutions. Clients have included a small city and county economic development organization. He has authored several articles related to economic diversification and development of school-business partnerships.

In 1992 he retired from the Central Kitsap School District as Administrative Assistant to the Superintendent. His responsibilities for community relations and internal communications caused him to work closely with issues of public and staff support for change and implementation of technology. He was also responsible for community education and for school-business partnerships and volunteers. As a member of the superintendent's cabinet, he worked to define the district's direction for change and technology.

His leadership in the business community resulted in the development of a communitywide Chamber of Commerce High Performance Community Committee dedicated to the application of Total Quality Management principles to schools, businesses, and government. The committee has sponsored educational seminars aimed at expanding the use of quality management principles to improve the quality of life and the competitiveness of business and education. Warren E. Olson has served as president of the Silverdale Chamber of Commerce.

He has previously served in the Clover Park School District in a curriculum development position as director of secondary education, as a high school vice principal, and as a high school English instructor. He has a master's degree in educational administration from the University of Puget Sound and a bachelor's degree in education from Pacific Lutheran University.

He currently makes his home in Zurich, Switzerland, where he is pursuing writing and cultural studies.

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Applying Quality Education Systems to Instructional Activities

A Quality Management Way of Life

Total Quality Education (TQE) is a way of life, not a program. To suggest that a cookbook on how to do TQE and technology could be created would belie the power that can be derived from the approach. Rather, TQE is a method of thinking about a problem and proposing unique applications of that philosophy or way of thought. Implementation of technology will be more successful when combined with a quality education approach that keeps the focus on the customer, the product, and the continuous improvement of the process to achieve quality.

Education Is a System

A quality education is obtainable when quality-driven processes are used to produce it. The addition of technology to teaching means fundamental changes in processes for learning. Because learning and teaching take place in a complex system, introducing technology to this system results in ripples of change that reach far into the corners of the system (Senge, 1990). As with most systems, the educational enterprise is running at 100% of its capacity, and the introduction of technology results in expansion or redefinition of major activities. Success depends on a complex response to the relationships within the system and a clear concept of how technology will change the processes of learning.

Applying Quality Education Systems to Instructional Activities

"An Education" as the Product of Learning

To practically apply quality education principles and technology, it is useful to think of "an education" as the outcome or the product of the system. Students should walk away from the system with an education that will make them economically competitive and capable of enjoying life to its fullest. Learning is the process by which each student creates the product. The students are the workers—no one can produce an education without students' active efforts. Work is learning and learning is work. The teachers are basically managers of the system. Technology is a major new partner in the process for improving the quality of an education with which a student leaves school.

The Student as Worker

Sometimes it is useful to think metaphorically of an education as something physical, something a person can take out of his or her head and hold in his or her hands. It is composed of many component parts and, more important, relationships between the parts. Without the relationships there are only isolated facts and bits of information. With the relationships information becomes useful and applicable. Only the student can assemble the pieces and make them work together.

The Teacher as Manager

The teacher and administrator become managers at different levels, who in a quality system must organize the workforce and must provide the tools necessary to encourage quality now and in the future. The view of the student as worker has many implications as quality education principles are applied through technology, not the least of which is the active involvement of students in decision making regarding their daily learning.

The central question to which teachers and administrators must always return as they implement technology is, How will technology improve the process of learning and thereby improve the quality of an education? A well-thought-out answer to the question will guide decision making.

Merging "TQE Customer-Driven Systems" With Teachers' Visions

Quality education approaches require careful attention to the needs and perceptions of the customers. It is likely that this orientation will not have been universally adopted within a teaching staff. Historically, the "teacher knows best," and his or her professional judgment has been the final arbiter of what was taught and how it was taught.

TQE and the effective use of technology will fundamentally change activities in which teachers engage. Teachers and administrators must carry on an effective dialogue regarding the implications of a customer-driven system if technology is to become an integral part of a TQE approach to learning.

Process for Consensus

Simply explaining who are the customers for education will not assure attention to their needs. A process must be developed to assist consensus building and to identify customer needs and align learning processes to meet them. The decision-making process explained in Figure 1.1 helps staff members know what they and their colleagues are thinking about a particular issue. It provides an opportunity for leadership to make clear its needs and then merges the direction of all stakeholders to accomplish change.

Once teachers' visions have been merged with those of quality education and applications of technology, the groundwork has been laid for successfully implementing change.

A consensus to focus on the needs of students as customers and on the needs of the community for educated people will

Robert Carkhuff (Carkhuff, 1989) describes a decision-making process that involves the people who are responsible for change in the initiation phase of the project. Although traditional management has "given" its proposal, "gotten" the reaction to the straw man, made some modifications, and then gone ahead (give – get – merge – go), the more effective change strategy is:

Get – Give – Merge – Go.

In this scenario the administrator who seeks change must carefully phrase the question or problem, set parameters, and "get" input and understanding from the staff before indicating what his or her needs are in regard to the problem. For example, a problem might be stated as "All of us are always seeking ways to improve the methods we have available to help children learn. Technology represents some promising opportunities to expand learning opportunities. What do you know about using technology and how do you see it helping students do a better job?"

Readings, visitations, and/or presentations by consultants should precede any request to formulate ideas for solutions. Viewing videotapes by Joel Barker is also a useful stimulus to thought (Barker, 1984). Careful and attentive listening to responses and proposals is essential.

Then it is appropriate to "give" the needs and the vision of the administrator or leader. Usually, many of the concerns and ideas of the administrator (or teacher, if the exercise is done with students) will be expressed by those who are responsible for the changes. In the case of applying TQE and technology to instruction, those needs would include attention to customer needs.

Next, "merge" the people's concepts and those of the leader to form a plan of action that meet both needs.

Do not forget the "GO!" All this will make no sense if the plan is not implemented. Success is highly probable because those who are responsible for carrying out the plan of action were the initiators of ideas and are implementing their own solutions.

Figure 1.1. Decision-Making Process

Note. From *Empowering the Creative Leader in the Age of the New Capitalism* by Robert Carkhuff.

provide a context for meaningful and extensive change. Such a consensus also provides guidance for the needs of internal customer chains of all the teachers who will help students create an education for themselves.

Translating Internal Customer Needs Into Action

Understanding how internal customer chains work will help teachers see the integrated systemic nature of the workplace and begin to understand the importance of change on a broad scale. Early attention to relationships will reveal the need for flow of information and the importance of data exchange between teachers. Understanding the interrelationships becomes an impetus to creating integrated technology systems that assist with change on a meaningful scale.

Internal Customer Chains

In TQE thinking, each person in the organization is alternately a *customer,* a *processor,* and a *supplier.* All members must know what the needs of the customers are and to whom they are responsible for supplying products or services. Figure 1.2 illustrates how one person functions in each role at different times.

Communication Is Essential

Communication of one customer's needs to the producer in the organization becomes essential to achieve quality education. Communication can be a cumbersome job in a traditional school that by its nature tends to isolate teachers in their classrooms. Electronic mail via computers on every teacher's desk can create an environment where communication flows more easily. Technology is a partial answer to support movement to quality education concepts.

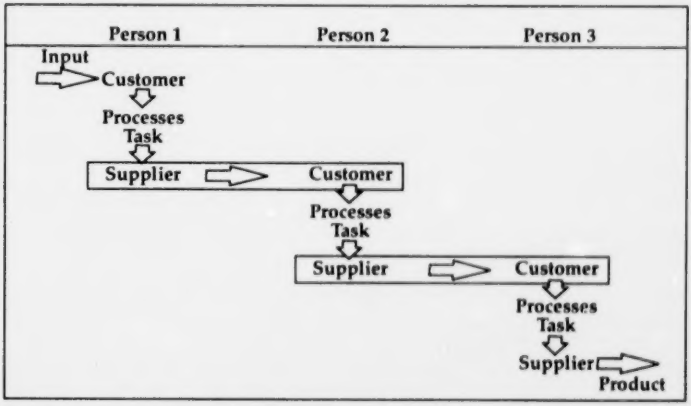

Figure 1.2. Customer Chains

Illustration of an Internal Customer Chain

Writing in complete sentences is a demand of the schools' external customers and will improve students' competitiveness as they enter business or academic endeavors; therefore, their education must have a "working component" for writing in complete sentences. That component must relate to all other components that require communication. Writing in complete sentences cannot be developed in isolation.

The student in this illustration becomes the *supplier* to whoever is "using" his education by reading the student's communications. While learning this skill the student is *processor*. His or her concerns are what processes should be used to help develop the skill. A large range of successful processes must be available, and the best will be one that accounts for merging his or her learning styles and predisposition with the needed outcome of 100% of the time writing without sentence fragments or run-on sentences.

Many traditional low-technology options exist, such as paper and pens, but increasingly effective higher-technology options are more effective. Word processors with the opportunity to revise are

a more efficient process. An even better one may be the use of grammar checkers to point out errors early in composition. Learning basic sentence parts may be facilitated by software programs that provide frequent feedback on sentence examples. Writing and producing video products related to assignments in areas of high interest offer still another more motivating opportunity. Involvement of the student as the worker in making decisions about how to learn is likely to strengthen the process by which learning will take place most efficiently.

The student then becomes a *customer* needing the services of the teacher and the school to accomplish the learning. The teacher must make a series of decisions about what will be most efficient and produce the highest-quality education in regard to this student. Access to a wide variety of methods, modern technology, and information about the students will improve the teacher's ability to supply the student with resources and instruction necessary for the student to accomplish the learning.

The teacher is the customer for the administrator who is responsible for expanding the resources and training necessary for the teacher to provide high-quality opportunities to the student. The district becomes the supplier to the administrator to assure the availability of training and technology to guarantee quality products to the final customers.

What emerges in this illustration is the importance of focusing on the quality of an education with which a student will meet the challenges of his or her life and the emerging role technology must play for that education to be truly competitive in a rapidly changing world.

Using Process Improvement to Increase Learning

Every effort at quality improvement focuses on use of a cycle of activities to continuously revisit and reevaluate the progress toward ever-increasing quality. The efforts with teachers and students should also fall into a continuous cycle of seeking improvement to the process of learning.

Cycles of Improvement

W. Edwards Deming used the Shewhart Cycle (Walton, 1986). Roughly summarized, (a) it studies the process to hypothesize what might be improved, (b) it makes the changes on a small scale, (c) the effects are observed and measured, and (d) the results are analyzed in terms of expected outcomes and side effects. The cycle is then begun again.

Many variations of the cycle have been illustrated in various works, but the essence is the same. It is essentially a scientific approach to improving quality. It relies on empirical information to determine if improvement has been made toward a goal and then disseminates the change more widely.

Measurement Is Essential

Important to the school administrator will be establishing commitment to the process on the part of participating staff members and then agreeing on what the empirical measure will be for improvement.

Measurement continues to be one of the most difficult issues for educators. Measurements should not be coupled to personnel evaluations or any public exposure that could be personally embarrassing to a staff member. Sensitivity to these implications will allow a safe environment for process improvement to take place. Risk taking must be encouraged.

Traditional and Nontraditional Measurement

As technology is introduced new outcomes and measurements become possible. Traditional measurement is meant to measure traditional learning. Only after 10 years of calculators becoming commonplace for use among students did the Scholastic Aptitude Test (SAT) finally allow using calculators. Traditional tests are not tests of future skills nor will they measure effectively what people who are attempting to "push the envelope" of education want to measure.

One example of changing outcomes and measurements is provided by the example of a handicapped student with highly limited social and basic functioning skills. The student was integrated into the regular classroom, and other students were taught how to work with her and what kind of expectations to have. The progress was dramatic, beyond anything predicted by the staff. When it came time for the student to move, the best evaluation of progress and capability was provided by a videotape of her interactions. The tape provided more information and helped better place her in the next situation than did most of the numeric or verbal data. Technology became a key factor in the evaluation of progress in this instance.

The important concept is to agree ahead of time on the suggested changes, their implementation, the appropriate measurement and then to take time to evaluate the implications and expand successful practices. Integrating assessment measures using technology can greatly facilitate evaluation throughout the process.

Leading Students to the New Role as Workers

The implication of using TQE to produce quality educations requires engaging students in new ways. More active methods of encouraging student involvement and expanding the ability of technology to change the methods and the evaluation and reporting of student learning means teaching students what learning is in the new context.

Student Involvement in Progress

Students who have been learning from textbooks and are used to a page of homework each night in math and a quiz twice a week may look at the time spent on a network computer system as fun and not associate it with learning. When they are asked by parents if they are learning math, it is not uncommon for them to say, "No, we don't use our books anymore."

It is important for them to understand that they are learning although it may be in a different fashion. Sharing results with them and helping them to come to clear understandings about what they have learned is essential. Even more motivating is bringing them into the process of selecting the next activities based on the results of the previous ones. The empowerment and attention to performance can accelerate the speed and thoroughness with which learning takes place.

A Curriculum in Responsibility

Students must be helped to assume responsibility for their learning. A curriculum must be created that can help students learn and practice responsible behaviors. Working with staff to design these curriculum units is important, and the curriculum should be revisited each year. Responsibility expectations should be taught as they are with discipline and other behaviors. The result of a carefully designed curriculum will be an increase in the ability of the students to participate in decision making regarding their own learning and improvement in the learning processes.

The curriculum content may be similar to in-service training that would be conducted with a workforce regarding TQM. The difference would be scaling the level down and providing opportunities to practice the skills as the students become more proficient at applying them. Technology will become a portion of such training. Depending on the technology used, the training will vary. The use of an integrated computer learning system will require different skills and training than the application of multimedia technology to special projects.

Cooperative Learning Improves Productivity

In schools as in TQM in the workplace, teams are often more effective at improving performance than just working with individuals. Group learning should not be confused with cooperative learning or team learning. Effective cooperative learning also requires teaching students the skills of cooperation and following a basic five-step process to assure that all involved students are

successful at the particular task (Scott & Elves, 1986). Attention to continuous improvement and appropriate measures of progress will help produce continually improving results. The team can also work effectively in environments where technology is not available to every individual student. Teams are a particularly effective method of working with multimedia productions.

Increasing Independence

As independence is developed appropriate to age level, students should become less dependent on the teacher and become more capable of making requests for resources they know will help them learn. In the role of manager, the teacher must welcome such requests and use them as means of assisting a student or a group improve performance.

As teachers work in a management role, they increasingly will have students examine results and demonstrate how the students can make decisions regarding learning based on the results.

Keeping Parents Informed

Keeping parents informed can be a new problem in classrooms that use technology. The traditional worksheets in the backpack may be replaced by computer printouts of student results. It is important to train parents in interpreting the results of student performance under total education systems and to develop systematic methods of communicating the success of students.

Helping Teachers' Transition to New Roles as Instructional Managers

Recasting a teacher's role to manager of instruction and changing the focus of teaching is likely to be a threatening transition. All people develop comfort zones around the habits and activities associated with work. The transition to a TQE format will become more comfortable if teachers are able to work as a team. This team should allow ample time to share the different feelings that arise

from new work modes. The teachers should also be reassured that change involves risk and that risk will occasionally result in failures. Failure is OK as long as the risks are calculated and no basic components of any student's education are placed at unrecoverable risk. As with physicians, the first rule is "Do no harm."

Key Terms and Concepts

"An education." It is useful to think of the product of schools as an education for each student rather than thinking of students as the product. Thinking of an education as a physical product with parts, subassemblies, and interaction of internal systems is a useful metaphor in understanding how TQM concepts from business may be applied to educational settings.

Continuous process improvement. In TQE, the effort to improve quality focuses on the processes that produce the product, and efforts are never ending to always make it better.

Cooperative learning. A specific five-step process for learning teams to follow to assure productive interactions of the group. The process holds all members accountable for learning, unlike simple group work.

Customer. The final user of a product or service. In education, it is the larger community and society, the employer, and the student who must use his or her education.

Customer chains. Within an organization several people may be responsible for a product or process before it goes to the final customer. Each of these people rely on the previous producer and form customer chains leading to the final product.

Customer, external. Someone outside the organization who uses its product or service.

Customer, internal. Someone inside the organization who will rely on what a previous person has done in order to successfully complete his or her own job.

Get – Give – Merge – Go. A method creating consensus for change that elicits input before presenting management's views of a particular question. The views are then merged for action.

Product. The outcome an organization or system delivers to customers.

Process. The steps through which a system goes to produce a product. In education it is useful to think of the process as learning and of the product as an education.

Shewhart cycle. An approach to continuous improvement that relies on steady improvement through careful analysis of results in an essentially empirical scientific method.

System. All the interrelated parts of an organization that contribute to a product or interact with those who produce the product.

Systemic change. The concept that change in one part of a system requires change in other parts because all are interdependent.

Teachers as managers. Visualizing the teacher as a manager rather than a presenter of information suggests that students are more involved in finding and using information and that teachers focus their efforts on analyzing instructional outcomes and making decisions about the most productive course for students to take in the next lesson.

Total Quality Management (TQM). A management approach that focuses an organization's efforts on continually improving quality as defined by the customer. The term is popularized and is often used in reference to the work of W. Edwards Deming, but a number of other researchers and consultants have developed similar approaches that focus on process improvement and analysis of results to improve the quality of a product.

Worker. The person who actually works on the product to be delivered to the customer. In education the student should be seen as the worker because no one else can produce an education.

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✧ 2 ✧

Helping Instructional Managers Change Classroom Practices

Helping and organizing change are key missions of any administrator. The old adage, "If it ain't broke don't fix it," does not work in a rapidly changing world. It is akin to the perfectly unbroken and serviceable horse-drawn plows that adorn antique shops.

Faced with creating a climate for change, the administrator should keep two key principles in mind: (a) Schools are a system and change must be systemic. It will not work to have just a few teachers who want to change do a few small things. They will rapidly run into the relationships to the whole system that will stymie them if other persons in the school or the district are not prepared to support the changes. For this reason the cross-disciplinary teams common to TQM applications are essential and invaluable. (b) There is a reason schools are not already doing things differently. Unless one understands why the change has not already happened, it is difficult to understand what will need to be changed in the system to have it occur. The key issues here are knowledge, ability to apply concepts, time for discussion and planning, and availability of technology for record keeping and instructional use.

Creating Shared Visions of Instruction and Technology

Creating systemwide motivation, or at least acceptance of change, requires developing a shared vision. Consistent with the

Figure 2.1. Four Elements Affecting Change

Get – Give – Merge – Go model is the one illustrated in Figure 2.1. It looks at four elements that will affect an organization's willingness to change. Those elements should be factored into a mission statement.

Time should be set aside for adequate discussion in small groups of each of the topics. Everyone should participate in a group of no more than five so their opinions can be heard. Proper phrasing of the question is essential to focused and successful outcomes. A sample question might be, How can we implement technology to assure continuous improvement of our outcomes? A sample agenda is illustrated in Figure 2.2 for such a meeting.

Facilitating a Climate for Change

In creating a climate for change, the administrator should continually attend to at least the following issues:

- Clearly stated vision and mission
- Support for risk taking
- Shared power and control of the process
- Reallocation of resources, time, and money to support change

Meeting purpose: Establish a mission statement and philosophy in regard to the question, How can we implement technology to assure continuous improvement in our outcomes?

1. As individuals, write down a few brief thoughts about the question in each of these areas: What facts do we have about technology and outcomes? What opinions do we have about technology's use? What do we currently do? What do we value as results of using technology?
2. In a group of four or five colleagues, share responses and try to come to a common list on which there is agreement.
3. In the total group, have groups report out their agreements. If one group has a similar statement to another, try to incorporate it into the first group to report the statement. Each successive group should have fewer and fewer statements because they will be reporting only ones that are different. Check to see if there is widespread agreement about each statement.
4. Based on the lists, ask groups to write a mission statement in regard to the question. Post the mission statements and focus on modifying the one that people find best expresses the sentiment of the entire group.
5. After a polished statement is arrived at, make sure it is distributed to everyone and prominently posted. This statement will be referenced frequently to keep change focused and on track.

Helpful hint: Consensus is often difficult to read as groups grow larger. A quick way to check and to make sure people respond to the question of consensus is the "fist of five."

To the call of the question, Do we have a consensus? each person must raise his or her hand and hold up between one and five fingers. Five means you wholeheartedly agree and will help lead the effort. Four means you will support leadership actively in working toward this particular issue. Three means you support it and will not oppose those actively working for it. Two means you disagree and will

Figure 2.2. Sample Agenda *(Continued)*

not support any movement toward it. One means you feel so negatively about it you would actively work against it.

If any ones or twos are present, it is important to stop and see what their objections are and whether adjustments can be made at this point to take care of their objections. Individuals must feel free to object. It is better to know now and try to accommodate the concerns. Remember, systemwide change requires the support of nearly everyone. More than a few people can frustrate the efforts of many others.

Actively working to generate a consensus on the mission or vision does not mean that the administrator cannot have a vision or participate in the dialogue. Vision and change are key leadership qualities expected of people in administrative positions. This vision can be merged in one of the groups or during the time when the mission statements are generated or modified.

The point of this exercise is that the organization cannot move forward until everyone's agenda is on the table and an agreed-on direction is established. Not everyone may want to lead the change, but it is important for those who do to have support from their colleagues.

Figure 2.2. Continued

- Attention to what is meaningful and aligned to the mission
- Evaluation and revision of processes
- Recognition and celebration of successes

Because the spark for change is often information, the administrator should work at keeping information flowing to those who are involved in the changes:

- Forward relevant readings
- Arrange for demonstrations, especially of relevant technology

- Arrange visits to successful sites to see the technology in action
- Share videotapes relevant to the desired changes
- Use consultants who can facilitate and inform
- Provide time for discussion and planning

Board and Administrative Commitment

Schools are part of a larger system, and because change in a school has implications throughout the entire system, it is important to seek endorsement for changes from the highest levels of the organization. A board resolution, such as the one shown in Figure 2.3, can set the stage for many related activities to move forward.

This board resolution led to the development of an entire districtwide change process that became known as Strategy 2020 (2020 vision for the year 2020). The agreed-on mission statement for the process is shown in Figure 2.4.

In addition to clear directions for an organization to pursue change, the behavior of administrators at all levels should reflect the emphasis on the process. Ways to do this include the following:

- Provide allocations in the budget to support the agreed-on changes
- Reallocate moneys from less effective practices to those emerging as promising
- Assign a member of staff to coordinate the change process
- Distribute documents that support and expand the thinking about change
- Develop common, consistent messages often repeated in public and targeted to different audiences such as parents, students, and teachers
- Focus efforts over a span of several years
- Provide time—secure days for planning, observation, and learning

WHEREAS, the education of our students must always be a forward and future-looking enterprise that contemplates the needs students will experience in their adult life; and

WHEREAS, Central Kitsap Schools have already recognized the benefits of being prepared for the future through the use of the most innovated teaching techniques and the most advanced technology; and

WHEREAS, those benefits have been recognized in student learning, individualization of instruction, the utilization of personnel, and the opportunity to provide significant savings for improved services; therefore

BE IT RESOLVED, the Board of Directors is committed to explore the most effective instructional delivery models, incorporate the best and the most cost-effective technology, and utilize the most up-to-date and efficient instructional techniques. The board is committed to these instructional delivery systems being utilized at the elementary, junior high, and senior high school levels, and that all new schools should be designed to accommodate and facilitate these instructional delivery systems. Any remodeling or retrofitting of existing facilities should accommodate the technology and instructional techniques provided for in the newer facilities; and

BE IT FURTHER RESOLVED, the board hereby authorizes and directs the Superintendent to develop for board approval new instructional delivery systems by involving the community and staff in their design. The board authorizes the Superintendent to enter into agreements and partnerships with vendors and corporations or institutions that will promote the development of new instructional delivery systems and to work cooperatively with staff, bargaining units, Educational Service District, and the Superintendent of Public Instruction to develop and expand these plans. The Superintendent shall annually prepare objectives related to these projects for board approval.

Passed by the Board of Directors of the Central Kitsap School District No. 401, Silverdale, Washington, October 12, 1988, after months of discussion and input by the total educational community.

Figure 2.3. Resolution No. 2-88-89

Note. Courtesy of the Central Kitsap School District, Silverdale, Washington.

Mission Statement

It shall be the purpose of Strategy 2020 to construct an instructional delivery system that better meets the needs of students both presently and in the future. New instructional and organizational strategies will be interfaced with technology to allow staff to be more effective, efficient, and attain a higher level of self-fulfillment.

Figure 2.4. Strategy 2020 Mission Statement

Note. Courtesy of the Central Kitsap School District, Silverdale, Washington.

- Share power and decision making with teachers, unions, parents, community, and students

Of all the above, power sharing is essential to widespread buy in and success for any change process. Boards and administrators increasingly should become facilitators of change, requiring that the proposals be generated in the field within broad parameters that may be set by the board or administrators. Decisions made in the field should not be remade by the board or administration but rather returned for further consideration with the concerns regarding the proposal clearly stated.

Finally, focus on the changes. Everyone in the organization should have a clear sense of what is the focus of change. That will only emerge through repetitive statements over long periods of time and with leadership behaviors that are aimed at supporting the desired outcomes.

However, the building-level administrator should not abandon efforts to infuse technology and TQE at the building level even if support from above is not apparent. Schools tend to function as a system within a larger system. Significant changes are possible as long as an understanding of the total system allows the administrator to see what impact the proposed changes will have districtwide and to chart a course of action to work around them. Although it may take longer, guerrilla warfare is often the most effective because it has the hearts and minds of the people.

Leading Teachers in Initiating Change

Unquestionably, the single greatest barrier to overcome is the lack of *time* available in most systems to pursue change. Most schools are lucky to spend 1 hour a week focused on change—that is less than 4 days a year. Administrators should seek creative time solutions so that teachers are rewarded for their efforts at change.

Making Time

One solution pursued by schools in the Central Kitsap School District was to implement a weekly early dismissal or late arrival of students. The time lost on instruction that day was added to the other days of the week so students had the same total number of instructional minutes. Before the change could occur, staff had to persuade parents that the time used to improve instruction was more valuable than maintaining the traditional schedule of dismissal each day.

To solve the problem of child care for working parents, parent groups in several schools provided enrichment programs during the dismissal time. Computers, music keyboards, dance, and *tai kwon do* became enrichment mainstays on the early dismissal days. The parent organization charged for the services and made enough money for needy student scholarships and to fund nearly $10,000 worth of additional activities. Other schools used the YMCA and the community schools' program to schedule activities for students. Staff feedback to parents on how the time was used and what results were obtained will create continued support despite the inconvenience caused by the dismissals. One school sent home a report of their activities after each early dismissal.

Focus

Keeping focused on the implementation of TQE and technology will send a powerful message about what is important. It should be the first agenda item at the faculty meeting. The important change issues should never share the same agenda with the mundane school operations items that must be regularly considered.

Collaboration

Collaboration is another important tool in motivating teachers. In addition to the obvious advantages of more minds thinking about the subject and the importance of representing all aspects of an organization during change, collaboration provides solidarity when challenged. It will also support the teachers making changes when the progress feels difficult and risky.

Homegrown Experts

Homegrown in-service activities can be very effective once the right environment has been created. All too often "outside experts" are hired more, because they are perceived to be more creditable than people on the staff. An effective strategy for sharing information is to divide a larger task and to ask teachers to work as copresenters in describing what they learn from readings, visitations, or their own experiences. If this becomes a norm, it builds not only substantial information within the staff, but these people will soon be in demand for consulting in other places.

Grants

Grants also provide an excellent motivator and resource to pursue change. A grant does not have to be large to have the effect of getting people working together to consider changes. Small grants of $500 or less often allow for the purchase of materials, registering for a class, or attendance at a conference. The process for applying for a grant also helps to clarify the task to be done. District-level money should always be budgeted for this purpose.

The Critical Mass for Change

It is not uncommon for an administrator of staff to want to take change slowly and in very small increments. Unfortunately, this attitude holds great potential for failure within a school. Too often changes in education have been on a small scale, one or two

teachers or a special program. The result is that they run into the limits of what they can change without affecting someone else's way of doing business. Or when the teacher leaves, the program dies. Establishing critical mass includes changing enough of the system so what is different is clearly evident and becomes institutionalized.

An example may help make the point. Special education staff believed that blending special students into the regular class and delivering services to them in the classroom would be beneficial for increasing the performance of special needs students. It would relieve the isolation pull-out programs create and could also help regular students learn how to work with those who are handicapped.

It makes little sense to simply put a special needs student into a lecture setting that is well above his or her level of understanding. So instructional practices must change if meaningful education is to be delivered to students blended within a regular classroom. There must also be time when the special services can be delivered in the classroom without loss of participation by the special student. The classroom simply cannot go on being organized like it was before and make the kind of change that will be meaningful. The concept can work if teachers can individualize instruction, use cooperative learning, and use a highly student-centered approach.

This change in turn requires that more program flexibility take place that becomes practical when integrated computer learning systems are used to maintain progress information on students. Teachers must be trained in cooperative learning, and time must be allocated to training. Special education staff schedules must be synchronized with activities in the classroom, rather than vice versa. This requires increased communication between staff that is greatly enhanced by the use of computers capable of sending electronic mail to every teacher's desk.

Methods of accounting for the special education teacher's time to meet state and federal requirements will need to be changed. This may involve people in the central office and accounting departments. It may also have implications for how staff time is budgeted.

The above illustration points out that to be successful no one new idea can be implemented successfully if the other parts of the system affected are not also changed. Willingness to change obviously must be generated across a number of persons. Some of the changes are dependent on technology and will only be effective after it has been installed.

The addition of electronic mail systems to almost any school will change the way in which teachers communicate and collaborate. E-mail allows messages to be answered when time permits and yet instantly links all facets of the school together. No technological tool is more powerful in assisting with change and movement to a TQE environment than the basic function of electronic mail on a networked computer system.

Reducing Fear Increases the Rate of Change

One of W. Edwards Deming's axioms is to drive out fear. Fear paralyzes organizations and often pits people against each other. Administrators can help people deal with it by either accurately contemplating the staff's concerns or by being sensitive and asking what the source of fear may be.

Teacher Concerns

For teachers, fear of trying something new may arise from their desire to make sure each student learns what they are supposed to know that year. If assurance of success is in doubt, then teachers may react with fear. Because this concern is understandably real, it is best dealt with by making sure the changes are done in such a way as to continually assure progress toward known goals. Short-term goals that are evaluated frequently are necessary.

Teachers may also fear pressure from peers for standing out and by implication suggesting that they are better than the other staff. Such concerns can be dealt with by using collegial teams, by creating an environment that appreciates risk, and by showing support for those who take the initial risks.

Teachers may also fear that if they accept some new and different responsibilities, they will not be able to return to their original teaching assignment or may be transferred to a different building. Pathways to "retreat" should be left open, and people should be reassured of their value in either the new or old role.

Parent Concerns

Parent fears are more likely to focus on whether their child will succeed at the next level and/or qualify for college. Changes should relate closely to outcomes, and information for parents should be prepared in noneducationese terms so it can be understood. It is important to remember that parents have gone through a school system and, therefore, may believe they are educational experts. If it was good enough for them, it should be good enough for their children. Parents deserve to be presented a strong case for change and reassurance that children will be monitored carefully to assure success. In many instances, parents and other citizens can be participants in the change process.

Student Concerns

Student fears may relate to status with teachers or the ability to show parents traditional indicators of success. Again, providing for alternative measurements and training regarding the changes can help ease the transition.

Do not be afraid to ask what the source of fear is. When the person shares negative information, it is important not to minimize it but to seriously reflect on the concerns and to seek solutions that will provide a greater comfort level.

Another successful strategy is to provide alternatives so that people may choose a course with which they are comfortable. In one instance where the reporting tool for evaluation was being changed from a traditional report card, the traditional way was left as an option. Parents could choose one or both. As the options become more familiar and people experience their effectiveness, change becomes easier.

Forming and Using Teams to Accelerate Change

Because effective change to use of technology and quality management principles requires systemwide impact, teams are almost essential to achieve results. The teams can be structured in several ways and have varying levels of participation.

The core of a team may be three or four teachers who are proposing to use technology in a particular way. They need to meet frequently and develop close relationships in order to make a project viable. The impact of the changes could have implications for librarians, kitchen staff, custodians, or business office staff. They should be included in the team but not for frequent or in-depth participation. It is important to include all those affected by the changes early in the process so concerns and potential impacts can be dealt with from the outset. Customers are also important members of the team, as well as people who may be suppliers. Determine all key players who are affected but do not expect long-term, in-depth participation unless it is needed. Including people at the beginning saves many hours later on.

An administrator must be sure to identify key elements of support for the team. Time to meet and plan is undoubtedly one of them. Decide how to support the change effort and establish communications links so there are no surprises for either the participants or the administrator.

Key Terms and Concepts

Climate for change. The feeling staff has for how strongly change is encouraged based on administrative response to proposals, as well as initiatives from administrators and leaders.

Collaboration. Seeking to establish changes with the active help and participation of all those affected by the change.

Critical mass for change. In any system each part affects another. To accomplish change, all parts of a system must simultaneously change in a coordinated fashion. The sum of the parts

necessary to effect permanent change is the critical mass for change.

Homegrown experts. Staff members who have been encouraged to become experts in a topic and who are supported in their opportunities to share it with other staff.

Tai kwon do. A non-contact martial art training program which emphasizes self-control, conditioning, and discipline.

✧ 3 ✧

Helping Teachers Apply TQE and Technology

Issues of Process Modification Based on Results

The application of TQM to teaching cannot be done as a formula or a set series of rigid steps. It requires thought and dialogue to establish mutually acceptable approaches. It is important for administrators to have a clear understanding of the issues and be able to lead teachers through some of the more difficult concepts. If TQE is to be meaningfully applied, it will require some significantly different practices in schools. One should not presume to use TQE and have the school look like it does today.

Essential to the use of TQM principles in business and industry is an emphasis on statistical control of process. For educators trying to implement TQE, this can be one of the most difficult implementation steps and one that will require creativity. Quantitative evaluation has as many limitations as it has strengths when applied to complex undertakings such as education.

Variability and Quality Definitions in Industry

Quality in industry is often synonymous with uniformity and lack of variability in component configurations and measurements for assembly processes. To most educators discussions about uniformity or lack of variability with children borders on the

immoral or obscene. Diversity has become a highly prized value of education, and it is important that discussions about variability not be confused with issues related to appreciating diversity.

Low Variability Desirable

At this point, the concept of an education as a product of schools rather than a student, or a person, becomes of value. One can have a high-quality education without having to be conformist in views or culture. Within that education one would expect low amounts of variability in many aspects to believe it was of high quality. Students are expected to consistently arrive at 4 as the answer to the question, What does 2 plus 2 equal? Correct and consistent use of periods, capital letters, and spelling are also demanded. High rates of variability in such areas are signs of a lack of quality and present serious problems for students and for the teachers who become the next internal customer for the student's education.

As in a machine, there are components of education that must be uniform and without defect in order to function with other parts. Each piece of a student's education relates to yet another, and each must be sequentially assembled and interrelated. This blueprint is called the "curriculum" in education. The next internal customer relies on the supplier to assure quality and reasonable uniformity or it becomes impossible to build the complex product known as an education. That does not preclude differing configurations of component parts that are in fact meaningful in preserving diversity.

Rethinking Variability

Education has tended to see variability differently. The bell curve, which describes so many performance criteria, has been used prescriptively rather than descriptively. As a result, a common practice has been to grade on a curve predetermining that the bottom few percent must fail in order to assure that the curve is meaningful for the remainder of the population. The result is to "discard" and create a rework situation known to educators as

remediation. The questions of what normal variability is and what learning processes produce results within acceptable variability are rarely raised.

The TQE approach to teaching is highly compatible with many of the criterion-based systems currently evolving. However, it provides greater opportunity to raise standards and marry process improvement to the approach. When implemented with technology, TQE can also effectively allow individuals to progress rather than being diverted to alternate projects while their cohorts reach mastery levels.

Technology can provide easily obtained and easily analyzed information on performance. The information can be current and provide for ongoing decision making regarding processes for improvement. Modern integrated learning systems and other software programs can present material and simultaneous interaction to assess learner understanding. The results can be captured and individual and group performance analyzed for further decision making. Although such results-based decision making is possible in a nontechnology-infused system, it is more difficult, time-consuming, and inefficient. In the already overcrowded day of the teacher, extensive evaluation and record keeping represent an untenable burden.

Moving Toward a Result-Driven Process

Agreeing on Results

Quality is normally defined in TQE as the "customer's requirements." In education that sets up a chain of customers for the education that stretches into the community, to employers and to postsecondary learning institutions. Input on requirements is best captured in long-term relationships between a school district and its community.

Internal Customers

The internal school customer demands can still be readily identified. The algebra teacher will require of students a certain

student mathematical background in order to proceed efficiently. The fourth-grade teacher about to introduce the concept of long division will require a certain proficiency of the multiplication tables.

The administrator should begin creating the results-driven process by focusing on the needs of the next customer in the customer chain. Teams are best constructed to include the next customer so there is clear communication to the supplier. Teams should look at the following:

What are the essential learnings every student will need?

What level of performance will allow them to succeed at the next level?

How much variability can be tolerated?

How can variability be reduced or expanded?

Measurement is critical to the process, and forms of communicable measurement should be identified to make the process meaningful.

Nonthreatening Applications

Developing measurements can leave teachers open to criticism. The profession has long resisted measurements that could become comparative. The administrator working with the process should avoid comparative thinking in relation to specific teachers. The challenge is to design a system that delineates outcomes based on customer needs and then is capable of engaging in process modification to produce results. The expectation should be clearly stated to teachers that results will not be used in teacher evaluation. Although some might argue for evaluation including the results, the potential misuses and the fear generated among staff argue for not getting involved in such threatening applications of results. The real issue is establishing parameters for success for students.

Measurability and Comparability

In the early stage, evaluation information is most likely to be used personally by both teachers and students. At later stages, benchmarking will help both focus on what others are able to do and what kind of competition will be faced in later education and ultimately in the workforce.

Benchmarking looks at the best and most competitive practices and identifies how processes can be built to assure comparable quality. Increasingly, as global competition emerges, such benchmarks will become globally oriented. In reality, American students will end up competing for jobs and business against others from all over the world.

It is unrealistic to establish a global benchmarking in the early stages of TQE applications, but it is wise to keep in mind that the performance levels agreed on should at some point be compared with what is happening in environments outside of one's own school.

Student Responsibility

Students are quite capable of participating in the analysis of results and making decisions regarding the next steps in creating their own education (Bruder, 1990). Cougar Valley Elementary in the Central Kitsap School District found that some students who used the integrated learning systems occasionally got bored and just pushed another key to get to the next screen on the computer. After sharing with these students the performance levels needed to move to the next level and providing them with some options on how to pursue the next objectives, the students saw their performance each day in a different light. They became concerned about reaching the correct performance levels, and their progress rapidly improved.

As with workers in the real world, understanding what is to be accomplished and having some power to determine how to go about it produced quality results.

Using Performance Data to Adjust Instruction

Once a measure has been identified and some means of analyzing results established, the real challenge begins of what to adjust in the process to assure continual improvement. Consistent performance within the acceptable range may be grounds for little action, but observations that indicate a drop in performance should be quickly investigated. As change is introduced, it is not uncommon to see an increase in performance followed by a downturn, followed again by a substantial upturn. The causes may be many but the pattern is not uncommon (Eastwood, 1993). If results are only being monitored over yearly standardized tests, little opportunity will arise for correction. More immediate and frequent measures will allow a team to identify trends early on and seek out modifications to instruction to sustain high performance levels.

Spikes in performance are really more interesting than the downturns. The question of what process was done differently to produce the positive results should be answered and then more frequently used.

In educational applications, process is thought of as steps that produce learning. A traditional process is for a teacher to lecture, to assign reading, to have students write answers to questions at the end of the chapter, and to correct the questions in class the next day. There are many substeps that could be included in analyzing this process.

Another process is to go to the computer lab and have all students do the introduction to a concept and interact with the questions. The teacher then analyzes the class results, breaks the class into groups needing different styles of instruction, and uses a manipulative approach with a group that has difficulty with abstract concepts. These are two different processes that are applied to the same essential learning objective.

The administrator can facilitate analysis of the process by using flowcharting and working with teachers to understand what steps are engaged in to produce learning. Flowcharting is a relatively simple process of looking at what steps are gone through.

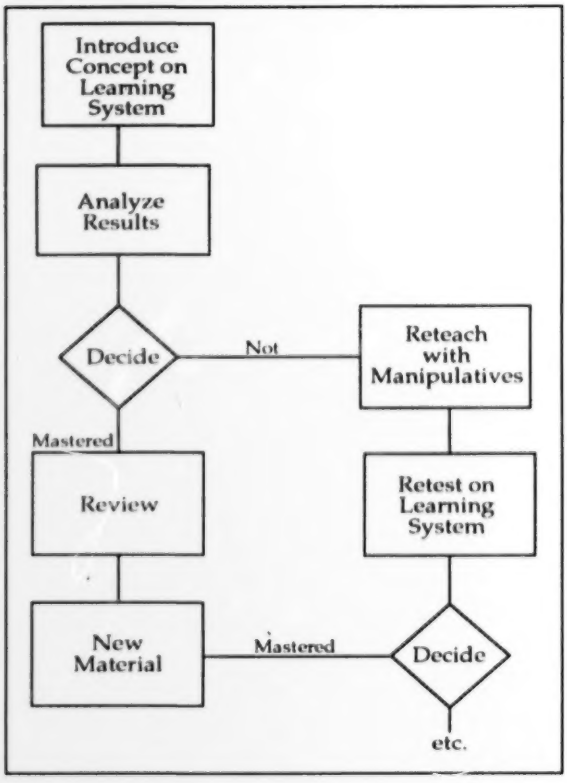

Figure 3.1. Instructional Flowchart

Rectangular boxes indicate processing; diamonds, decisions. Figure 3.1 shows a flowchart indicating the process in a lesson.

Teaching Repertoires and Technology

The purpose of analyzing a process related to learning is to find which techniques and processes are equal or most effective. Teachers need to use a repertoire of practices to reach all students.

In moving with a staff toward applying TQE, teaching methods should be ever-expanding. In-service training in cooperative learning, mathematics manipulatives, whole language approaches, and technology should become a regular feature of the school (Sheingold, 1990).

The administrator should be the facilitator of time and resources to accomplish the training. Developing experts within the staff and having them share is one of the strongest strategies to have the methods grow and develop among teachers. It is important for a culture to be developed that appreciates, supports, and uses local expertise. A staff with depth in its access to different methods has greater opportunity to fine-tune processes for improved performance (Usiskin, 1993).

Using Student Input

Students, too, go through a process as they learn. Working with students to flowchart their processes can help them see what they can alter to improve their performance. If the steps in studying material are to read the chapter and then answer the questions, students can be led to more effective learning processes by including steps such as outlining, formulating questions, scanning headings, or learning to read sidebars. The students, too, should be in a quest not for one formula that works but for various processes they can apply. Flowcharting and attention to results can assist them in making better personal decisions about their own learning processes.

A student's learning style may impact the most effective process for him or her to learn. A basic understanding of the learning modes the student prefers can be a starting point for designing a process that will take into account which methods may be most efficient for him or her to learn. Students should be helped to have insight about what works for them and then be included in planning how best to learn.

Technology offers tools that can emphasize different learning styles. Students who prefer visual and social interactive situations will find producing video or multimedia presentations more engaging than only reading about a subject. The interaction of the

keyboard and mouse may provide manipulative opportunities for students who need a hands-on component.

Changing How and Why We Evaluate

Increasingly in an instructional system oriented to quality education, evaluation should be aimed at identification of an effective process rather than ranking students. As with people working successfully everywhere, students will perform at different levels. Students will have a range of variability in how they perform. Labeling the worker or the student does not produce a higher-quality product. Adjusting the process based on analysis of results can.

The administrator's role is to lead staff to change how and why we evaluate. The demands of old report card systems that report to parents that their student is midway between the highest performers and lowest performers in the classroom and so will receive a C does not inherently lead to improved quality.

Ending Rework Cycles and the Evils of Remediation

In industry one of the goals of attention to quality is to end expensive rework cycles. Educators should seek a similar goal. Attention to performance and efforts at improving process reduces the need to create separate remediation services for students.

Remediation often takes students away from progress in the regular classroom. As a result they fall farther behind their peers. Remediation requires additional personnel and creates additional administrative costs. From a quality education standpoint, creating processes that assure expected performance levels the first time students encounter material would produce significant savings. It would also reduce labeling of students and the discomforts created by being "pulled out" for reteaching.

Effective remediation programs often rely on variations in process related to learning styles or how material is presented. Such services should be integrated into the regular classroom and

viewed as variations in process. Such practices expand the teaching methods available in the regular classroom and focus effort on successful levels of performance for all children.

Assessing Total Quality Education

Although TQE processes and technology play a significant role in the teaching and learning process, a legitimate question that must be asked is, Has all of this resulted in better learning for students? Assessment and accountability are popular words and important ones. Progress by students and staff as well as a critique of the curriculum must be a part of any TQE program. Figure 3.2 illustrates what the elements of technology are for an idealized assessment program.

Standards must be determined and form the base of the assessment system. These standards are derived from national, state, and local goals. In addition, postsecondary institutions have requirements. So does the teacher. New to this standard-setting group are the "customers." From all these inputs, the essential learnings will be determined.

Technology again plays a key role in the assessment program. It allows not only for efficient management and record keeping but it provides the teacher and the student the ability to monitor progress. Benchmarking is important as is the possibility to measure more than just content. Software programs can provide for reteaching, offer learning alternatives, allow immediate feedback to teachers and students, and be a cause for celebration. Report cards can quickly be produced via technology as well as other forms of reporting student growth and accomplishment of the essential learnings. Videos, portfolios, and examples of the fine arts can also be captured for individuals or groups of students.

When the Central Kitsap School District could find no commercial system that included all those components, it designed its own. There were available programs that purported to do the job but lacked one or more factors and required more technical expertise than most teachers possessed or were willing to learn. The goal became to develop a software program that would allow

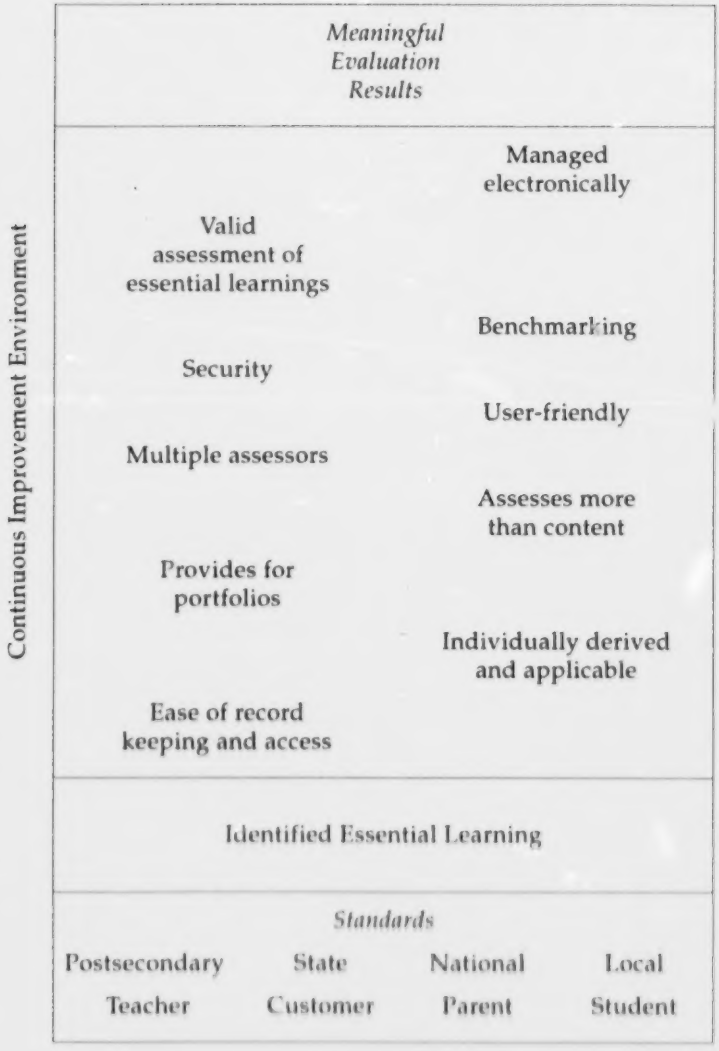

Figure 3.2. Technology Components of an Effective Assessment System

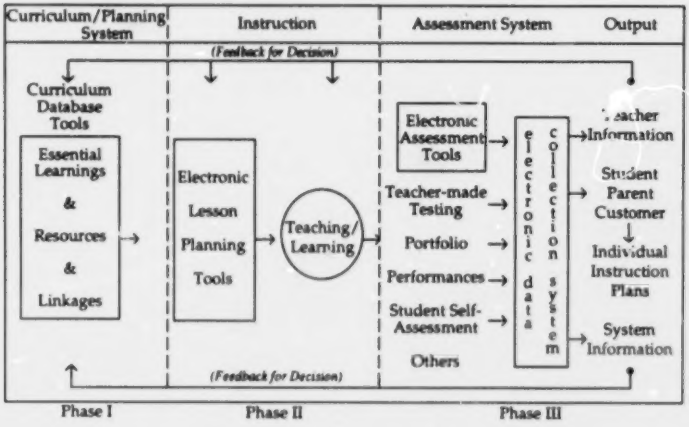

Figure 3.3. Teachers' Instructional Mapping and Management System

access to all the district's essential learnings at any of the networked computer terminals. All support material for each essential learning is coded to that learning. Included are references to textbooks, library resources, portions of media programs, lessons on the integrated learning system, teacher-made materials, and other software programs. Some of the resources can be accessed directly on technology, and the location of others is referenced. Because the network program includes access to the student data system, many possibilities become available. Teachers can plan instruction for individuals or groups of students on their computers, print it out, or leave it on line for access by students.

Figure 3.3 illustrates the Teachers' Instructional Mapping and Management System (TIMMS) developed by the district in collaboration with Synectics, Ltd. of Seattle. Phase I has been completed and implemented. Phase II will be field-tested in late 1994. Phase III is in the planning stage; however, several schools have already used compatible software allowing for automated report cards based on the essential learnings and for portfolio storage.

TQE processes allowed this teacher-friendly system to be developed at a minimal cost and in a reasonable length of time. No teacher will be forced to use the new system, but the ease of use

and the saving of time will make it an indispensable tool for the teacher.

Inherent to the system is the ability to allow both student and parent access to appropriate components of the system. A teacher working with the student and the parent now has the potential of developing a personalized educational program for that student. The student and the parent can also become partners with the teacher for the accountability of the accomplishment of the essential learnings and much more!

Key Terms and Concepts

Benchmarking. Identifying some outside organization's service or product that is considered the best of its kind in the world and then comparing the results of one's own organization's products and services to the selected standard.

Comparability. Measurements of quality that can be compared to other world-class standards for benchmarking. Performance on the same test provides comparable results; performance on two different tests may not provide comparable results.

Manipulative approach. A teaching strategy that focuses on using the hands to manipulate objects as a means to understanding rather than just using a listening and reading approach. Some students appear to learn more easily when dealing with concrete objects than when dealing with abstract concepts.

Measurability. Results that can be observed and counted are considered measurable. Measurability is essential to developing benchmarking or comparability.

Quality. In TQM, quality usually is defined by the customer demands plus what the supplier knows the customer may need from his product in the future.

Rework. Any time a product falls short of its quality standard and must be redone to bring it up to standard. In business, rework can be a major expense and elimination of rework a source of efficiency. In education, it takes the form of remediation that represents a major additional expense in teaching.

Teaching repertoires. The collection of instructional strategies in which a teacher is competent. A large repertoire of techniques allows a teacher to select the most effective one for a given situation.

Variability. Deviation from a standard of quality performance. Variability is inevitable and according to W. Edwards Deming, quality management focuses on understanding and reduction of sources of variability.

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✧ 4 ✧

Selecting the Right Technologies

Easier, More Productive, More Self-Satisfying

Technology is a strategic decision on how to accomplish the learning goals of a school. The right technology is dictated by the vision of how the technology can help students learn. Equally important is how technology helps teachers teach. Technology must make the teacher's job easier, more productive, and more self-satisfying. If it does not accomplish those three things, technology will not be used by teachers. They are already busy, and only those practices that are easier, more productive, or more self-satisfying will have a chance of replacing the activities already in use.

Alignment to essential learnings, mission statements, and the interests and abilities of staff will also play a major role in determining which technology should be selected. The point of working through the process identified in the earlier chapters is to build a consensus to ensure use of technology. In an era of limited resources, purchase of the wrong technology, or that for which no support for use exists, is an expensive and unproductive decision.

Selection Processes

Process again will play a significant role in selecting the right technologies. Fundamental to any TQE approach is modeling the process in reaching key decisions. The list in Figure 4.1 suggests a series of steps to guide a selection team (Hertzke, 1993).

1. Identify instructional goals.
2. Identify possible roles for technology.
3. Identify criteria for selecting technology.
4. Identify available technology and vendors.
5. Compare available technology to criteria.
6. Evaluate finalists through a search of research literature.
7. Evaluate finalists with site visits and reference checks.
8. Invite vendors for an interview.
9. Determine service, support, and cost.
10. Select technology system.

Figure 4.1. Guide for Technology Selection

It should be noted that the process in Figure 4.1 allows participation by salespeople only in the last steps. Dynamic salespeople can have a tendency to skew decision making. The sales staff and support systems are important to the purchase but should not obscure the performance features essential to assure the system meets the staff's needs. Salespeople also have a tendency to change with unfortunate regularity. The person the staff relied on to help them may not be available for assistance by the time the system is delivered and installed.

Compatibility Standards

District and school standards are another important consideration in selecting appropriate technologies. Computers usually fall into two categories: IBM-compatible and Apple. Although file transfer between these operating systems is often advertised, beware of how complex it may be and what limitations it may inherently have. Networking is complex enough in either environment to make connecting between the environments something requiring substantial technical skills. Both environments have be-

come user-friendly and easy to learn if properly configured. Decisions should be made with an eye to the future and an awareness of the importance of networking as a productivity tool.

The actual hardware or platform for the software should be compatible with district or school standards. District standards have the advantage of allowing stocking of basic parts, and therefore the rapid exchange of a broken component for one off the shelf. Standards can result in building greater expertise on the part of district technicians and more rapid repair and service. Where possible, whole machines can be substituted without serious interruption to instruction.

People are likely to have favorite machines, software, or operating systems. Be careful of prejudgments about any of these areas. The most important issues may be the compatibility and service criteria. Relearning may be the least expensive part of the total system life span costs.

Network Considerations

Networking opportunities are a significant consideration in the purchase of computers. In a decentralized system, productivity is lost when the machine is turned off. In a network system, productivity can be captured and shared. An example is the student doing math practice work on a stand-alone computer. When the machine is turned off, the teacher is back to traditional evaluation with testing, correcting of tests, and scoring to be done before being able to assess progress. In a network system, the correct and incorrect problems can be captured by the system and the results can be made available to the teacher on his or her own computer. This makes life easier and more productive for the teacher and speeds the time to make decisions regarding next instructional steps for the student. It is also possible to aggregate information about the class and identify possible groups encountering the same difficulties. The student, too, has the opportunity to continue or to begin a new lesson from another location in the building.

Network systems also have capability for E-mail and for sharing of projects. People who do not have a network system available to them sometimes find it hard to imagine why they want one; those who have worked on a network system find it hard to imagine ever being without one again. Teachers in the Central Kitsap District state that the increase and the ease of communication with other staff was the first indication that technology could be more of a help than a hindrance. Ease of record keeping was another reason. Thorough investigation of network systems and purchase of compatible equipment is a wise step before selecting computers (Hertzke, 1988).

Making the Argument to Parents and Community

Everyone is an expert on schools. Everyone went to one. What was good enough for them to become successful is probably good enough for children today. The argument for adding technology may meet resistance in some parts of a community.

Many working people should be involved in the process. Anyone whose job has changed to become more productive through the use of a computer understands how much computers can change our world.

One technique that is often put forth at meetings of parents and teachers is to take a poll of the technology now in their own homes. This is often most productive with parents with teenagers. The poll is visual for the group and asks that people hold their hand up with the appropriate response in the poll.

> Question 1: How many TV sets are there in your house? If you own at least one leave your hand up. Two, leave your hand up. Three, leave you hand up. And so forth. In a typical middle-class neighborhood, two or three sets are not uncommon.

Point out that it is an unusual school that has one set per classroom.

Question 2: How many telephones are there in your home? At least one, leave your hand up. Two, leave your hand up. And so forth. Again, multiple phones are not uncommon, especially in homes with early teens.

Point out that telephones are a nearly century-old technology that have not found their way into classrooms. Yet for most people they are one of the most common information sources when paired with the yellow pages. In fact, educators have had little experience with how simple technology like a telephone can impact instruction.

Question 3: How many families with children have at least one video game? Two? And so on.

Indicate that each video game has more electronic memory than is available on computers in most classrooms.

The point is, most students live in an interesting and enriched world outside the classroom. They go home to international news and call-in shows that bring people together from all over the world. Putting technology in schools is doing no more for students than what parents have seen fit to do for them at home.

Identifying the Available Technology

An exhaustive discussion of each of the available technologies is probably a book in itself for each technology. The following discussions are offered as starting points for discussion and investigation.

Integrated Learning Systems

The integrated learning system (ILS) has great capability for solving the widest range of problems. It can provide delivery of instruction, assessment, and analysis of results. It often provides communications tools such as electronic mail or linkage to wide

area networks or remote databases. It delivers systemwide tools such as word processing, graphics, databases, and spreadsheets. An ILS can share third party software and with proper licensing agreements reduce costs while increasing access. Large CD-ROM information packages can be added with multiple port access. In short, an ILS is a versatile and true educational workhorse.

The hardware in an ILS is typically a network of computers linked to a central file server. The hardware has typically been stand-alone computers that have sufficient memory to be used on or off the system. "Dumb terminal" systems have keyboards and monitors at each station but rely on interaction with the file server for every transaction at a terminal. The "smart" stations have additional memory, and the system can download portions of software and files to the computer where they are used by the students and then returned with results to the central file server. The results are then accessible to the teacher.

The software is held on the file server or an attached larger memory device. One file server component is the actual operating system that allows the computers to talk with each other. The other major component is the current software that is routed through the file server. Laser compact discs often offer the needed storage for the quantity of information that is needed on the system.

Major ILS vendors such as Jostens Learning Systems and Edunetics provide a software product that covers many individual lessons in mathematics, reading, language arts, and science. The lessons are sequential and interactive. The system will retain how many tries a student makes, whether or not the response to the item is correct, as well as the time spent on the activity. Results can be viewed by the teacher in reference to individuals or groups. The software allows selection and grouping of individual students for specific instructional purposes.

Typically, an ILS will allow access to what is called third party software or software that has been developed independently of the primary software produced for the system. The third party software commonly involves access to large databases such as on-line encyclopedias and other reference works that may be stored, for example, on CD stackers.

There is also an ongoing debate over whether an ILS is worth the money or whether students' needs could better be met with a collection of third party software from which a teacher could choose and then assign to students. Although this approach may be ideal, curriculum decisions do not happen that way. Teachers are too busy to screen software programs and then piece them together for individual students. An ILS does this for the teacher, provides sequential testing and branching for remediation or acceleration, and includes a management system, too. For the great majority of teachers, the ILS is a very usable, time-saving tool available to meet individual students' needs.

There is always the decision over whether an ILS should be in a lab setting or dispersed to the classrooms. Opinions will vary, but teachers at the Cougar Valley Elementary School in Silverdale, Washington that pioneered the use of an ILS in both situations would choose the lab setting first. They cite flexibility as the reason. The teachers wanted the opportunity to have a whole class on the system at the same time for certain instructional purposes, but they also wanted to have the option to send students to the lab independently. Nearly all labs have 30 or more computers and class size is generally around 25. Where flexible walls are built into a school, teachers prefer to group computers closer to the classrooms. Chapter 7 will discuss an ideal facility for the use of technology.

The ILS and network capability provide opportunities for students and staff to continue to grow into the system and software. The versatility allows growth over several years on the system and provides for more solutions to be developed to instructional problems.

Local Area Networks

One variation of integrated learning systems is to create a local area network (LAN) in conjunction with the learning system. Typically, it uses a similar hardware configuration with a central file server and a computer on every teacher's desk. Its purpose is to reduce the unproductive distractions of teaching and to allow the business side of schools to run more smoothly.

If teachers each have a computer on their desk, such a network system can allow electronic mail and other services to be delivered to each classroom. Fundamental tools such as word processing, graphics packages, and databases can be delivered to each work station. Figure 4.2 illustrates the services that were identified by teachers in the Central Kitsap School District as ones desirable for inclusion on their LAN.

Initially, the goal was to install student computers in each school as quickly as possible. After the installation of the first LAN with electronic mail for teachers, the Central Kitsap School District set a new priority. The goal changed to having a computer on every teacher's desk as rapidly as possible. What was discovered was that the communications provided in electronic mail changed the basic nature of work among teachers. Collaboration became more possible; scheduling meetings and arranging student conferences with specialists was easier. Teachers saw how technology could help them save time and do more.

The speed of delivery of instruction shortened. In one incident the day after the San Francisco earthquake, a library aide came to work at one school and told about earthquake experiences she had. The librarian put a message on the network system announcing her as a resource person. Within 15 minutes she was a guest speaker in the first classroom and spent the rest of the day talking to other classes.

Simple things such as finding extra volleyballs for recess became easy. Put a note on the network and within 15 minutes a dozen balls for recess become available. The ability to access resources from all over the school reduces the need to hoard or duplicate.

The LAN offers rapid communication without interruption of class. Public address announcements virtually disappear. Messages for students to call home do not need to interrupt the class. The systems have a reputation for making teaching more efficient and more humane. When technology makes teaching easier and more rewarding, teachers are anxious to use it.

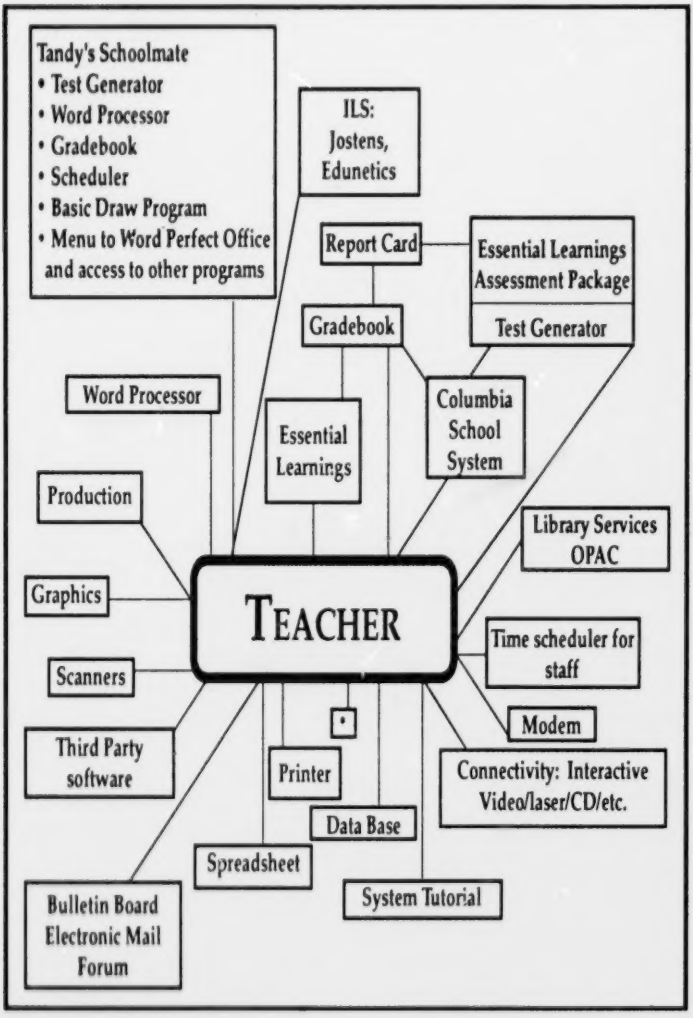

Figure 4.2. Local Area Network Teacher's Perspective

Note. Courtesy of the Central Kitsap School District, Silverdale, Washington.

The inclusion of basics such as attendance and lunch counts make the system immediately necessary to do business and are the starting point for a more complex use of the system. It also allows the computer novice to become confident and an advocate for the system. This learning and convenience make the transition to instructional systems easier and more positive.

Networks can provide access to software of varying complexity. Some programs are as simple as games. Others offer sophisticated learning interactions. One of the network's advantages lies in having one copy with licenses for many users rather than buying software for each machine or location. Licensing arrangements can reduce the temptation to illegally copy software and are much less expensive.

Issues that need to be considered in the construction phase of such systems involve whether to make them coaxial cable connected, fiber-optic, or wireless. Each has its own advantage depending on location and the ease with which a system can be retrofitted or designed into new construction. Fiber-optic systems offer the advantage of transmitting larger "band width," which typically will allow for video broadcasting or interactive video. Because the costs can be substantial, careful consideration of future needs and available resources is important. If the features of the network are likely to require the capacity of fiber optics, it may be less expensive to build it in the first place, rather than tearing out wiring and retrofitting the system at a later date.

An in-between solution is to build in a conduit with the wider turns required of fiber optics but to fit it with a coaxial cable. The cable can allow for a first-generation system and can be relatively less expensively replaced with fiber optics when the time comes. This is especially prudent where the conduit is buried in concrete in the floor—tearing it up is really ugly.

Stand-Alone Systems

If resources are unavailable for networks, stand-alone systems can still provide some significant learning advantages. One use is the Higher Order Thinking Skills (HOTS) lab created by Sam Pogrow at the University of Arizona. The program integrates

Socratic questioning with various software, both public domain and vendor provided. The program was designed for use with elementary special-needs students but has demonstrated success at advancing skills in reading by helping gifted students to think at higher levels. It has been successfully applied to all fourth-grade students at Silver Ridge Elementary in the Central Kitsap School District.

The strength of a program such as HOTS is its ability to integrate the human and computer instructional components. The application of technology provides a standard base of instruction on which the teachers can build. The program has clearly stated goals and a prominent role for the application of technology.

Once again, the importance of clear goals and a clear role for the technology add strength to the success of the program. The planning and agreement of staff on what is to be accomplished are important to the effective use of technology. Even with visitations and pilot projects, however, it will be difficult for staff who have not experienced technology to be able to imagine its full potential.

Tool use of computers is another important stand-alone function of computers. Tool use means the use of a program to accomplish another goal. Word processing is the best example. The computer technology is a tool to produce a written paper. The paper's learning goals may be very independent of the capability of the equipment. A somewhat higher use of the word processor is to use the equipment in the context of teaching the processes of writing. The editing portion becomes particularly effective when the entire paper does not have to be rewritten to accomplish the editing.

With upper-elementary and older students, tool use becomes increasingly important. Applications such as databases can provide fascinating tools for analysis in history or social studies. Spreadsheets can be adapted for science and social studies projects that require modeling of different algorithms, assumptions, or data. In any of these cases, the stand-alone computer becomes an asset for more meaningful work by the students.

The limitations of stand-alone computer labs or stations becomes apparent when it becomes time to evaluate the projects or learning. More innovative methods will need to be devised to

assess and to establish progress than might be built into an integrated learning system. Software licensees may also present limitations on use. Monitoring of the system for viruses passed disk to disk can also be more difficult than on a network system.

One major advantage of stand-alone systems is initial cost. Networking is expensive, and if a school does not have access to a technician and the ability to keep a network functioning, the stand-alone systems offer simplicity and reduced cost. Networking is not a foolproof, out-of-the-box application. Proper wiring or fiber optics is essential, and relatively high levels of technical competence are required to solve network problems.

Aside from the licensing costs, the stand-alone system can provide a less expensive way to achieve computers for tool use such as word processing. In many applications where the computer is strictly used to produce another product, the stand-alone system may provide simplicity and cost savings. It is possible to plan ahead to allow for eventual conversion into a LAN.

CD-ROM

The compact disc read-only memory (CD-ROM) is an optical data storage system. The on or off binary code that provides information for computers to work is held on a compact disc (looks like the audio one) and is read by a laser. The primary advantage of CD-ROM storage systems is the quantity of information that can be easily stored and easily accessed. One disc can hold the equivalent of over 20 feet of books on a shelf.

CD-ROMs are popular for holding entire encyclopedias, or other compilations of large data, on a single disc, including graphics and pictures. Sound and images, both of which require large amounts of memory, can also be encoded and practically accessed on the equipment.

The major advantage to the user is the rapid search capability of compact disc technology. A library paper search for references to a topic can require hours of tedious work. In the electronic environment, typing in a few key words and pressing a button for a search command can find every reference to the words in the entire encyclopedia in a matter of seconds. Research that used to be burdensome and frustrating becomes easy and pleasant.

When residing on a single stand-alone computer, such systems tend to dedicate the computer to that use and restrict the number of students who can access the system at one time. When CD-ROMs are a resource on a network, typically more students can simultaneously access the information, and as they finish using the resource, their computer can be used for other learning tasks. This also means that computers in a classroom can access and share a central data source. The placement of the computer in a classroom is like putting a set of encyclopedias in each room.

CD Stackers

The CD stacker can take multiple compact discs and make them available to network situations. A stacker with seven compact disc databases will allow as many as 100 students at different computers access seven data sources at any time. Such systems provide a critical mass of available technology that allows schools to truly change how they do business. Research can take place from anywhere in the school. More students can access information at their own times rather than having to be scheduled into the library.

Videodiscs

A cousin of the CD-ROM is the laser videodisc. Typically larger, it is used for capturing video or visual information. A single disc can hold in excess of 50,000 pictures making it a rich source of visual information for science, art, or history. It can also hold moving picture images and sound, making it a hard, disc-shaped counterpart to the videocassette. It can play back still images with greater clarity and stability than is usually available in a videocassette.

The greatest strength of the videodisc is the ease with which information is accessed. The disc can be searched in less than several seconds and the next image displayed on a monitor. It becomes an ideal tool for illustrating lectures or presentations. Information can be either in the form of still images or motion images with sound. Dual sound tracks can allow more than one language to be available from the recording.

Videodiscs do not require a computer to be used, although they become even more useful when that is the case. The image can be displayed on any standard television screen or video projector.

Multimedia

As the term implies, *multimedia* uses more than one medium to covey its message. It typically will involve presentations that use pictures, sound, and graphics to convey the message. Likewise, it will use some combination of hardware to produce the presentation. The most common combination is to link a videodisc player with a computer and a video monitor or television set.

The computer is used to write a program that selects different videodisc images as they are needed for presentation. It can also supply written graphic messages to the screen to supplement the images or to ask questions or present outlines during the presentation. Voice or sound can be provided live or through recorded text, either on the videodisc or independently of it if the computer has sound capture capabilities.

The programs for multimedia presentations are usually created in programs such as Hypercard or Linkway. They allow for questions with multiple-choice answers and "buttons" on the screen that, when selected, can lead to another screen either explaining the correctness of the choice or why it was incorrect. Other buttons can allow exploration of related topics or visual information.

Multimedia presentations can be used for large-group instruction or can be kept available at a station where students can access them as needed.

The creation of an effective multimedia presentation can be very time-consuming, and it is unlikely that most teachers will have the extra time required to create numerous multimedia presentations as regular teaching tools.

A more promising use of the multimedia station is to have students create the presentations. They can do research for the basic content and then find the images to illustrate it. Such pres-

entations make excellent team activities. Creation and presentation of a finished product provide for a variety of learning outcomes to be simultaneously accomplished. The Tandy MPC is an excellent example of an inexpensive, but expansive, program for student or teacher use (Hertzberg, 1992). In addition to the benefits derived for the students on the team, the product can be used to teach other students. Products can be retained and used year to year.

Webbing of information becomes possible when using authoring devices such as Linkway or Hypercard. Information webs allow facts and ideas to be related but not necessarily in sequential ways. An example would be the creation of a program about whales. The text could explain their place in the animal kingdom, and pictures could illustrate various kinds of whales both in still and in motion. Secondary projects might add buttons that allow students to explore topics such as whaling and international treaties on whaling. Each of the additional topics can be projects for other teams in a class or in subsequent years. The learning product can keep growing in value and usefulness.

Interactive Video

Similar to the multimedia presentation, interactive video combines the videodisc with the computer to use a more inquiringly or interactive mode of instruction with the student. These products are typically commercially produced and present questions or situations that may be answered in several ways. Depending on the answer, the consequences of the choice can be illustrated on the videodisc. Products range from business-oriented customer service situations to chemistry experiments that allow errors that only blow up the fictitious lab on the screen (a considerable saving to most districts). Driver-training labs have used similar materials for some time as a means of presenting students with realistic, real-time, choice situations.

Interactive video is extremely useful when dangerous situations need to be presented and when students need to be given safe opportunities to think about choices and review consequences.

Video Production

Students can learn by watching video, but they can learn even more by producing video. Video has become one of the most powerful information sources in contemporary society, yet few students understand how people build such magic power into simple pictures and audio. Having students develop complete video projects not only helps them understand the topic of the video but to understand the media itself.

Video requires more than a camcorder to be effective. Editing equipment is essential to a successful production. The more sophisticated the equipment is, the easier will be the final steps to viewing; however, with the home video craze a number of inexpensive alternatives have emerged.

Video can be produced in several formats. The most common format and the one that most home and school video players use is the video home system (VHS). It is a relatively low-quality picture with limited numbers of lines per inch of screen and a relatively low resolution. This presents problems when copying or editing because each successive generation of tape loses quality. By the time the first copies are made from the editing master, they are third-generation images and often have colors bleeding and distorting, and the edges of lines become blurred. The quality of the product is so substandard that it is unusable with an audience.

This problem is overcome by taking the original video and editing in a higher-quality format. Either Super VHS or High 8 can provide adequate quality in what is called a *light industrial market*. The camcorder should be in this format so that the editing can occur without significant loss of quality.

To edit, at least one video deck is required and the camcorder can be used for the other. It is better to have two video decks, one for playback and one for record. It is also possible to get by with one monitor, but again, the ease of editing is aided by having two so that both the playback and record decks can be monitored.

Essential to the system is an edit controller. The controller allows the mechanical portion of the decks to begin operation before switching on the electronic portion. If a controller is not used, every edit will have a flicker or pull to the screen distracting the viewers.

High 8 systems have the advantage of being highly compact and relatively easy to carry and use. They will have to be rerecorded to VHS to play on most of the VCRs in a school. This will normally take a special High 8 to VHS deck or two separate decks. The Super VHS is not as compact and is more cumbersome in the shooting phase, but the Super VHS tape cartridge is the same size as the VHS cartridge, and consequently, the editing decks are usually built so they can accept either format and automatically switch the electronics to the appropriate type.

If a school is serious about being able to produce video, it is important to buy equipment that is actually designed for editing and that is of the higher format. Buying the slightly less expensive VHS formats usually results in having to replace them within 1 year to get the quality people expect to see. A somewhat larger investment at the beginning will result in longer lifetime use and higher satisfaction. Our experience is that there is a substantial appetite for the equipment and projects, and the investment in quality equipment is well worth it over the lifetime of the equipment.

Such a system should also provide for basic desktop video production. The system can be expanded by adding a mixing or special effects board. Systems of this complexity are relatively easily learned by elementary school students and can be learned by teachers without extreme investments of time.

Small fortunes can be spent to buy more complex video production equipment, but time investment and complexity suggest they be reserved for advanced programs where students have some interest in video as a vocation. The video toasters and computer-driven editing provide excellent special effects and are fascinating tools but are not highly productive without extensive training and frequent use.

Do not overlook the students as teachers of how to use video and editing equipment. The high-interest and high-motivation nature of technology will usually develop some local experts who can be called on for training of other students or teachers.

During retrofit or construction, providing for a video distribution system within the school allows for a sense of community to be built around shared programs highlighting the school activities. In the Central Kitsap School District, several elementary schools have gone to their own news production, sharing weekly

programs about the school. It is a powerful tool for creating a sense of importance as students see themselves on the screen and for creating a sense of identity and community within the school. It can be used to solve problems. A 60-Minutes-style exposé about the chaos at the bicycle parking rack resulted in instantaneous changes of behavior on the part of the riders who afterwards parked neatly.

One important advantage of video is the opportunity for students who are sometimes overlooked for low verbal or mathematical skills to participate and achieve success. The media appeals to different learning styles than are most commonly served in traditional schools.

Still Video Image Camera

Still cameras that record an image on a small magnetic diskette have proved enormously popular with students doing reports and working on school-oriented projects. Sometimes called "Xapshot cameras," they are about the size of the popular point-and-shoot cameras and come with built-in flash units. Extra lenses allow close-up work for duplicating pictures in books. The images can be transferred directly to a videotape or can be used in multimedia presentations. The camera also provides limited animation capability.

The fact that no developing of film occurs and the diskettes are reusable make them economical attributes to any multimedia presentation efforts. They are especially useful for recording classroom presentations or activities that can then be shown to parents or retained in a portfolio for evaluation. The still video camera is a powerful tool in making the activities in the school real for parents who cannot be there during the day.

Video Overhead

At first glance, the device looks a little like a regular overhead projector except where the mirror usually is located is a small color video camera mounted so it can view what is happening below it on a surface. The camera is hooked to a 27-inch color TV

or monitor and displays what the camera photographs. A series of close-up zoom lenses allow the camera to turn tiny magazine photographs into 27-inch classroom displays or to capture wide-angle larger projects being done for demonstration.

Properly mounted on a swivel head, the camera can be turned toward the classroom or a student giving a presentation. Linked to a VCR with the TV monitor, students can be recorded giving reports with the tapes sent home as part of the accountability to parents.

The video overhead is more versatile than the regular overhead because it can photograph opaque objects. In one classroom demonstration on predation, two insects were placed in the same dish. The predator would eventually eat the other insect, but it was not something that was going to happen on cue. The teacher set up the demonstration and started the VCR. The class continued with its other lessons. They could watch the happenings in the dish out of the corner of their eye on the monitor. Eventually, the predator struck and the class saw it live and had it captured on videotape.

Demonstrations of mathematics manipulatives, calculator use, art techniques, and others can be seen clearly by the entire class through such a system. The systems are commercially available or can be constructed by local in-house technicians from surveillance cameras and stock zoom lenses.

The Teaching Wall

Developed at Silver Ridge Elementary, the staff designed the front wall and cabinetry of each classroom to have two sliding-panel white boards that covered the shelving behind them. The installation looks like a normal two-panel white board. When one board is moved to the side, a 27-inch TV is located behind one panel with a VCR below it. The video overhead can be hooked to it for demonstrations or the VCR used to play commercial tapes or student-generated work. Each TV monitor is hooked into the schoolwide system so that comprehensive video communication is possible. The wall includes storage areas as well and provides an organized base of supplies and materials for the instructor.

Computers with video output devices can also be linked to the larger monitor for demonstrations. One "teaching wall" can be connected to another to allow for team presentations.

Communications

Communications technology is often overlooked as a critical component in helping schools improve learning performance.

The most obvious communications technology is the telephone. No other professional group would conceive of having one or two phones for 20 or 30 personnel and then wonder why there was not more communication between parents and teachers. Telephones are a regular part of students' homes and yet are rarely found in classrooms. When adults seek information, their first reaction is often to seek out the yellow pages and look for an expert.

Telephones can be used by students to locate information and also to improve linkage to home. With a telephone in every room, it is possible for a student to call his or her mother at work and tell her about the excellent presentation he or she just made to the class. Such a resource should not interrupt classroom presentations, so voice mail systems are almost a must. The voice mail system will also free the school secretary from many additional calls. The opportunities for telephones in the classroom have been limited, and relatively little curriculum has been developed around their educational value. Fears of the misuse of telephones did not materialize in the Central Kitsap School District where there is a telephone in every classroom. Adequate safeguards are readily available for little cost.

As phones and phone lines become more accessible, the opportunity to use modems to connect to large remote databases becomes a reality. Resources are accessible through modem range from local bulletin boards to international networks. Bulletin boards can be established between schools or within a school. A bulletin board is basically an electronic blank wall that a person can access through a modem and leave a question or a comment. As many other people as wish to comment can respond. Modems also provide access to information services such as Compuserve and Prodigy that make a wide variety of current information available to users.

Fax machines are a reality of business. Most businesses find it hard to imagine living without them—much like their copy machines. Schools do not need one per classroom, but a fax machine is another technological tool that can improve instruction. Students who are faxing written work to another student or adult are more likely to become concerned for the absolute correctness of the document. The immediacy of the receipt and the rapidity with which a response can come are incentives to communication.

Schools that are interested in creating international partnerships should consider communication by fax. It is relatively inexpensive for the immediacy of response.

Core to internal communications within the school should be the electronic mail system. It provides a reliable method of communication without interruption. Better yet, it allows communications to whole committees with a single correspondence. Lists of who is on a committee can be generated and a memo sent only to those people with a single transaction on the computer. Likewise, everyone on the network can be messaged or only one person can be messaged. In the world of telephones, pencil, and paper, multiple calls or copies of memos would have to be circulated to accomplish the same effect.

The ease of communication creates a more collaborative atmosphere and breaks down the barriers created by classroom doors and walls. This level of communication is critical to successful systemic change and use of TQE processes among a faculty.

Distance Learning

The National Aeronautics and Space Administration's (NASA) Space Program produced an offshoot that has greatly benefited schools. Generally called *distance learning*, this new medium uses telecommunication via satellite to allow teaching and learning to take place throughout the globe. A number of cooperatives have been organized through universities such as Oklahoma State and Eastern Washington or by a single state such as New Jersey. Subscribers can pay for specific courses for one or more students. Courses include the content areas, foreign languages, and vocational programs. Teacher in-service programs emanating from the

TI-IN network, San Antonio, Texas, are also popular. A number of nonprofit initiatives such as the Galaxy Institute for Education and Hughes Aircraft Company have introduced interactive satellite communications networks that link students across the United States and internationally. Students receive educational programming by satellite and can exchange lessons via satellite with sister schools.

To make optimum use of this instructional source, classrooms need to be wired to a satellite downlink or receiver and equipped with a 27-inch (or larger) color television set, videocassette recorders, computers, telephones, a fax machine, and a camcorder. Although basic instruction can be done with only the downlink and the television monitor, the other equipment makes the classroom become alive and interactive.

The greatest disadvantage is cost because the subscription fee is almost always an additive to the budget. In some of the content areas, a teacher can be replaced by a noncertified classroom monitor.

Choosing Between the State of the Art and the Obsolete

Probably, no decision can cause an administrator to wake up in the middle of the night in a cold sweat more than trying to choose the right brand and model of equipment, especially if entire labs or large systems are being purchased. What if it does not work? What if the one next year is twice as good and half as much? Some trends have emerged in the electronics and computer world that should offer some assistance.

First, computers are not like desks or chairs. It may not be a virtue to buy the bulletproof, crushproof, markproof, childproof model that lasts for 50 years. Computers change as do the operating systems and the software designed for them. Ten years is a long life span in the personal computer industry because of the rates of change.

Should one buy the newest and fanciest? Price trends over the years suggest that new lines of equipment are expensive, and it is not uncommon for there to be some bugs yet to be worked out. Prices usually fall within the first 1 or 2 years of production as

competition increases. There is then a relatively stable time when the equipment is basically state-of-the-art, affordable, and with a reasonable life span ahead of it. Sometime, a little further along, prices may drop suddenly. Salespeople will try to persuade you of the deal of a lifetime. Unfortunately, this is usually just before manufacturing of the line is discontinued and the company is trying to get rid of all its inventory. The problem of buying late in the cycle is that software vendors may not continue to support the hardware and within a few short months the really desirable new software will not run on the old equipment. Some companies have made large deals with school districts and supplied thousands of computers at bargain basement prices only to withdraw the line from the market. New software was written for the latest platform so the district was stuck with no new releases.

The answer seems to be to buy at least 1 year after a product is out or after some evidence of a price drop. Do not buy old established lines if the price is suddenly falling radically. Try to buy in the middle of a cycle. Consider replacement within 5 to 6 years, and count yourself unusually lucky if you get 10 years good service from any of the rapidly changing and expanding technologies.

From Whom to Buy

Buy from established national companies! Increasingly, there are highly competitive custom-built computer systems being marketed by small local manufacturers. They often buy parts from various vendors and build a hybrid computer. The assurances are always given about it being a working clone of one of the really expensive companies, only you do not have to pay for the research and development and marketing costs so you really save. In some instances, technicians within a school district may assure you they can build the machines internally for a fraction of the cost.

Maybe. Sometimes the systems work fine, but all too often they come with their own little peculiarities, and solving why some standard software will not work can be a long and costly experience. Meanwhile, the systems may be down, and there is a real cost in not being able to have reliable, workhorse systems that

operate consistently. Even the best and most standard and established hardware and software companies encounter difficulties in large networked environments. The best software is usually guaranteed to work on a specific hardware system so that inclusion on a network causes minimal adjustments.

How much risk does one want to take? For our money, staying with major vendors and writing performance contracts seems like the safest approach to reliable systems. These vendors not only have the resources to assist with problem solving but they also have experience and expertise to compare your problem to similar ones in other environments. This approach may offend the local hackers who assure you that the parts they order through the magazines are the same ones that the big guys buy and that the overhead in their garage is a lot less than the big factories' overhead. Too much is at stake for the average administrator to risk his or her reputation on the skills of someone they are not qualified to evaluate. The small operations also have a nasty habit of disappearing within 1 or 2 years, and the parts they use fail and cannot be replaced.

How Much to Buy

At one time equity issues prompted districts to purchase their hardware and software all at once and place it in every building. This kept away complaints of one child having a computer and another not. The practice, although seeming fair, resulted in huge capital outlays for equipment and placed significant quantities of it in schools that were not ready to use it. Worse, one can project the obsolescence and the need to replace all technology at the same time with yet another huge capital outlay. Such actions are not popular with the taxpaying public.

An alternative is to base purchase on critical-size purchases (one computer lab, or a network for a school with a computer for each teacher). It does not make sense to buy too little to accomplish the mission of the instruction program. Base the location and implementation on which faculty are ready to use the equipment

and how they propose to accomplish educational missions. To receive the first computer systems in the Central Kitsap School District, a competing school had to submit a request for the system indicating how they intended to use the lab. Only a few schools were ready in the first purchasing cycles and those labs were well used. Parents began to place pressure on faculty members and principals to get the labs for their schools, and the readiness to accept the technology grew rapidly. As more schools became ready, more updated equipment could be placed in each subsequent school. At the end of the first cycle, approximately 4 years, all schools were equipped, and the first schools were ready for full LANs. It makes technology a fairly consistent replacement item in the budget, but it assures continual updating and appetite for the next system.

Evaluating Technology Based on Its Instructional Role

Before purchase, the team or faculty selecting technology should be clear about the role it will play instructionally. This is difficult because without experience of technology it is hard to imagine how much teaching could change. Only after systems are in place do people fall into habits of using them, which can fundamentally change teaching activities. One is tempted to imagine doing the same things and having technology present. Real technologically based change causes different actions and behaviors to occur.

The Right People

The group to match the technology to the instructional goals should not just represent the "techies" in the building. Aim for the average user. The person with no computer experience and substantial fears is likely to give good advice about how user-friendly a system needs to be in order be used. A faculty member who is fascinated with computers and who spends all his or her spare time playing with them is unlikely to understand the frustration encountered by the rank-and-file teachers. They believe that others

can learn and frequently underestimate how much time it will take to become proficient in use. When the techies enthusiastically say they want to take the software home and spend 5 or 6 hours to learn it, beware of what kind of learning time that represents to the uninitiated whose hobby is not sitting in front of a computer.

Be sure a range of instructional interests is also represented. Not all teachers are comfortable with innovation. The teacher with vision of how radically technology will change things needs to be balanced with one who is happy to make more modest revolutions.

If the system does not appeal to the 80% of common users, it will fail. The 10% on either end may be unhappy, but other accommodations can be made for them. One should not let the wild-eyed or dug-in drive major user decisions.

Imagination Is a Key

Imagination is still important. People will have to stretch to get the most out of the systems, and the decisions should be a mixture of fantasy, reality, and good guesses. Beware of "vaporware." It is neither hardware nor software but something where someone says, "You know, wouldn't it be neat if we had a system that . . . ." The imagined system may be like the quest for the Holy Grail and cost untold hours of probing the ether for the vaporware.

Establish Criteria

Decisions focus more rapidly when a list of criteria has been developed. Use a matrix and rate each hardware or software solution against each other. The best at one criterion receives a "1," the second best a "2," and so forth. When all the criteria are added up, one or two systems or products will emerge as the finalists. Carefully evaluate them against each other. Simply going with the low-point winner assumes that the criteria were omnisciently derived. Sometimes the final look will supersede the criteria with good rationale.

Possible Criteria

DATA MANAGEMENT

Does the system allow retrieval on learning performance?

Can it store the information and in what forms is it then available?

Are those forms usable for teachers or do more steps have to be taken?

Can the information be applied to decisions? Which ones?

Does it give teachers more or less time?

DIRECT INSTRUCTION

Does the program match the curriculum? What would change?

Is the material appealing?

Should textbook selection criteria be applied?

Are there cultural or minority biases?

Is it really sequenced to help students with very little teacher intervention?

Will it automatically branch to provide reteaching opportunities?

MERGING INSTRUCTION AND EVALUATION

How much independent assessment will be required to assure learning?

Are results easily accessible?

Will the results be in a meaningful form?

Will the students and parents be able to understand the results?

CREATIVITY TOOLS FOR LEARNING PROCESSES

Will the technology be readily learned so creativity can take place?

Does it have enough depth that as students grow they will still be challenged?

What kinds of learning objectives can be achieved?

Can it be used with other media or equipment to create more sophisticated products?

Avoid Prejudgments

Most forms of technology end up with advocates based on their home use experiences. Whether dealing with video or computer technology, the needs of school use may be substantially different than those experienced at home or in the office. Be sure the decisions at school are based on instructional criteria and not the convenience someone has experienced on a home system.

Visiting Technology in Action

Nothing answers the question, Does it really work? like an actual visit. Most schools will be looking to implement technology that has already been tried somewhere before. Going to look at the school and how staff and students use the system is invaluable. The trip should be planned during regular instructional days so the system can be seen in operation.

Who Goes

Determine who and how many get to go. Establish the funding that is available, and then ask the team responsible for implementation to identify the participants whom others trust to report back. Some kind of cross section is important, and people who will be rank-and-file users need to see and understand the systems under study. Again, getting the skeptic's views is desirable and necessary. Do not send the same people each time; however, it is good to include a veteran in the new visitation team. Remember to include classified personnel, too.

Finding Technology in Schools

Vendors are sometimes a good source of who is using what and where. Take time to ask who their "star" clients seem to be and who to contact. Some schools are visited so often that regular schedules for visitation have been established to minimize disruption.

Articles in education technology magazines are also a rich source of leads on who is having the most success with technology. Conferences and professional organizations offer yet another opportunity, and consultants may also be familiar with successful programs.

Persons contacted should be asked who else they know is doing similar things and who they admire for their progress. After checking with several of the better leads, the one that has the programs and interests most similar to your own should emerge.

Pictures and a 1000 Words

A camcorder and someone who is astute at selecting what needs to be videotaped can provide an invaluable tool for reporting back to the rest of the faculty. Permission to film is important. Be sure to videotape some of the more important conversations that should be brought back unfiltered, and unedited. The pictures will add reality to the description the team brings back and make communication of ideas easier.

Know the Questions

Before going, in fact, before the initial contact, it is wise to have a list of questions the group would like to have answered. This helps the people you contact know whether or not they can help you. It makes the trip more efficient and saves you and your hosts time in looking at irrelevant things. The questions will focus your efforts. Do not be surprised if your host has some related issues he or she wants to share with you. As organizations experience systemic change, teachers may discover some relevant areas that will change what you are considering.

When possible, send a list of the questions ahead so your host can be even better prepared.

Being Good Guests

Most organizations are flattered by your wanting to observe them. Normally, they will go out of their way to share professional insights and help you not make costly errors. They are, however, fully engaged in teaching and learning and may be busy or have unplanned emergencies come up during your trip. Visiting groups should be flexible and plan their timing so observing can be mixed with time for conversations.

Try not to interrupt activities unless you have asked the teacher for permission to talk with students or are sure the teacher has time to talk with you. Visiting groups need to be extremely quiet and are often better broken up into smaller groups of threes or fours to lessen the impact of their presence.

Reporting Back

The lucky ones who traveled now have an obligation of finding ways to accurately communicate what they saw. Formal presentations to the entire faculty are often best because no one gets left out if they missed the lunchtime conversation. The team that went should organize their thoughts and be prepared to give both sides of issues when there are differences of opinion. Accuracy of reporting is important for credibility of the project.

Cycles of Growth and Replacement

As noted earlier, computers and technology are not forever. Newer, better equipment and software will come along. Hard drives and keyboards do wear out. Obsolete parts become hard to find. Planning ahead for the eventual demise of the system is important. It can significantly reduce waste and provide continued impetus to innovate and improve instruction (Finkel, 1993).

Planning Alternatives

An example of thinking ahead occurs when computers are chosen that can be networked or used as stand-alones rather than dumb terminals. As the system reaches the end of its life span, the computers can be retired to less active service in classrooms, libraries, and special clusters of computers for creative or word processing use. The computers also might be made available to families whose children need special assistance or might be clustered in a room for access by the community after school hours. The computer's usable life span has been extended and put to creative use. In the case of the dumb terminals, the system is likely to simply have to be scrapped.

As equipment is purchased, ask how it might be used if it were not used in its first or primary application. The answers may help determine what is purchased and provide a plan when challenged regarding its use.

Upgrades, When and Why

A shorter-term question will be the frequent upgrades to software. The upgrades are usually less expensive than first-time purchase and in some cases present significant improvements. Sales agreements should include statements regarding upgrades, costs, installations, and assurance of compatibility with the existing system. Often the upgrade may not significantly improve the current program, but just be the company's latest release. Watch for upgrades that require significantly more memory or data storage capacity. Your current hardware may not be capable of running the expanded versions.

If file transfer by disk is contemplated on stand-alone computers, it is wise to establish policies of everyone staying on the same version of software until a universal upgrade can be established. If very little compatibility is necessary, the issue simply becomes the needs of the individual user. Adding new users to the environment will be a problem if older versions of the software are no longer available.

It is imperative to have adequate time to test the upgrade and to be sure the "bugs" have been solved. This takes time and should be done only during vacations or the summer break. Downtime for students raises the frustration level of both students and teachers and eventually causes a return to the reliable materials of the past.

Once again, it is imperative to address the issue of upgrades before it arises and to determine how they will be budgeted and what criteria must be met to establish the need for universal upgrades.

Long-Term Relationships to Vendors

In the case of some continually evolving software programs such as the integrated learning systems with ever-expanding curriculum updates, it may be wise to simply factor continual upgrading into the cost of maintaining the system. That will assure state-of-the-art support for the most critical systems in a school. Such services are usually competitive and affordable on the larger market. If one's school has difficulty budgeting the costs, it may be worthwhile to contact other consumers and see how they have been able to manage on roughly similar resources.

System Planning for Data Exchange and Comparable Results

Three issues can be examined in determining which information and results need to be communicated. First, it is important in designing systems, particularly ones that capture results, that the usefulness of information be assessed in terms of the customers who will use it and the decisions they will make with it. Among the potential customers for information about students are other teachers, parents, and the student. If the systems are not designed to obtain results that can be compared to either established criteria or performance of other populations, the meaningfulness of the information is substantially reduced.

Second, attention to the issue of "who next" will use the information is one way to create meaningful definitions of results that should help drive the decisions about what hardware or software to purchase for particular instructional goals.

If a faculty has begun to think about the issues of benchmarking as it applies to education, it will be important to obtain and use data that can be compared to other "benchmark schools" or results. Contemplation of what will be needed for meaningful comparisons that lead to improvement can save significant time, cost, and energy when quality education techniques become more data driven. Technology should make teaching easier and more rewarding. Careful thought about the use of results at the time of technology selection can make it an even more usable system.

Buying Capacity Beyond Immediate Vision

Until technology is in place, it is hard to contemplate exactly how it changes lives. Decisions should allow for people and the systems to grow together. Buying too small is a little like the gardener who fails to estimate the size of the mature tomato plant and puts it in too small a pot. The yield is decreased and life span shortened for the plant.

Technology purchased today should provide a context for growth for nearly a decade. It is important to set high expectations for use by buying systems with capacity for growth. If no one in your district feels capable to advise, seek help from an expert in another district or employ a consultant.

Key Terms and Concepts

Apple. Hardware and software that operate on Apple systems. Generally viewed as the "other system" than MS-DOS, which is most closely associated with IBM-compatible equipment and the many similar personal computers. Apple and MS-DOS systems can communicate, but problems are not uncommon despite efforts

to make them able to talk easily to each other. Apple is known for its pointing an arrow at an icon with a mouse in order to initiate basic functions such as saving or opening a file. Microsoft Windows now provides this feature for MS-DOS platforms.

Camcorder. A video camera recorder capable of recording pictures and sound simultaneously. Available in several formats, for example, VHS, SVHS, High 8, Beta, and so on.

CD-ROM. Compact disc read-only memory is a storage device like a hard drive, only typically with larger memory. The memory can only be read; it cannot receive new information after it has been manufactured. Large information sources such as encyclopedias are available on CD-ROM. The ability to rapidly search the entire database for entries make the device ideal for research purposes.

CD stacker. A device, usually on a network, that allows several CD-ROMs to be run simultaneously. Numerous computers (100) can have simultaneous access to the information.

Compact disc. Small laser-read disc that holds optically encoded information.

Graphics. Reference to any text added to multimedia presentations for explanation or questions.

Hard drive. A memory storage device holding large amounts of information permanently installed in a computer or added as a peripheral.

Hardware. The "actual machine" that allows software to be read. Computers, video players, and a variety of other devices are referred to as hardware. The information played on them is referred to as software.

Hardware platform. Usually refers to the brand of computers selected or to the operating system chosen for the systems.

High 8 video format. A video format that will allow editing with minimal loss of picture quality ("one step up from VHS"). Characterized by extremely small tapes and lightweight, handheld equipment.

Integrated learning systems. Networked computer systems characterized by the ability to deliver instruction and curriculum as well as provide access to tools such as word processing and electronic mail. A data management system is generally included.

Interactive video. Normally consists of a computer and a video laser disc player that make it possible to integrate instruction and questions on the computer with visual sequences from the video player.

Local area network. A computer network in a limited area. The network could be as few as two computers to as many as fill a single location. A typical school will be connected through a local area network and may consist of 200 to 300 computers.

MS-DOS compatible. One of the two most common operating systems; Apple is the other. MS-DOS is an intermediate programming of the hardware that allows other software to run. MS-DOS requires written commands to do such functions as saving information or opening previously used files.

Network systems. Groupings of computers that can all communicate with each other and are capable of running software that functions as a system.

Replacement cycles. The time at which computers or other hardware have been superseded by newer better technology, and/or maintenance and repair become prohibitive either from a cost or from a loss-of-use standpoint; the time when the manufacturer or software vendor no longer provides support for the equipment.

Software. Generally refers to the information or program that hardware will make readable or accessible to the user.

Stand-alone systems. Groups of computers used for a similar purpose but that are not linked together to communicate.

Still video image camera. A camera about the size and appearance of a 35-mm point-and-shoot film camera that records images on small magnetic discs. The discs can then be played back on any video monitor or TV. No processing is required. Images can be recorded over.

SVHS format. Sometimes called Super VHS, it is a higher-resolution video format than VHS but uses a video cartridge of the same size and shape. SVHS is more appropriate for editing and then making copies into the VHS format.

"Techies." Slang for those students or staff members who are comfortable and skilled at technology and because of high interest levels are usually knowledgeable.

Tool use. Refers to use of computers for creative projects such as word processing or graphics creation as opposed to use as a delivery mechanism for curriculum or the study of the computer as an end in itself.

Upgrades. Usually a reference to software or operating systems when a new version with more features is placed on the market. The upgraded product can typically use the old files, but users of the older version often cannot access files created in the newer version.

"Vaporware." Slang for the imagined software that would accomplish some desired task—"Can't you just imagine a program that . . . ."

VHS format. Common video format available in video stores and that most video players used in schools accept.

Videodiscs. Large discs that are optically read by a laser and turned into still or moving video images. The still images are of a higher quality and greater stability than those usually available on videotape. Images can be randomly accessed at great speed.

Video overhead. Use of a small video camera on a stand that allows viewing of the image on a video screen. Typically equipped with zoom and close-up lenses, the apparatus can magnify small pictures or actual demonstrations and allow viewing by a class.

Video production. The process of planning, scripting, shooting, logging, editing, and presenting a finished video presentation.

Webbing information. The ability to treat information nonsequentially. One can find relationships between topics and ideas that do not require step-by-step thinking or processing of information.

Wide area network (WAN). The networking of computers over greater distances up to and including global networks. Typically references the ability to link a series of local area networks so that people can communicate between them.

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✧ 5 ✧

Implementing Technology to Maximize Its Use

Identifying the "Critical Mass" for Systemic Change

To accomplish change in a system, it is necessary to make changes on a scale that will allow all related parts to change in a coordinated fashion. A similar issue exists with the quantity of technology and how it is configured in a school. As with the nuclear reactor, too little and it sits cold and unproductive, too much and it melts down. Getting the right amount of technology is critical to its becoming a staple of instruction.

If technology is relatively rare and requires special planning to use, its practicality is limited in the busy day of the teacher. If there is enough of it so it is available just about any time it is desired, its use begins to expand. The issue is how to configure the technology and provide adequate amounts of it without having quantities that would be uneconomic.

Computer Technology

How much should a school buy? Where should it be located and why? Assuming that the integrated learning system is one component on a local area network, a school can choose between several configurations.

A Computer on Every Desk

A LAN to be useful needs a station for every teacher, administrator, and key support personnel such as the custodian. To have less than that will compromise the ability to include everyone in messages and will create a system of those who know and those who do not. It is possible, however, to create multiple "mailboxes" at a single computer station when more than one person is assigned to a particular room or station.

Distributing Computers to Classrooms

The distribution of the computers within a school has several options. One way is to distribute the computers to the classrooms. Typically, this creates a learning center in the classroom with four to six computers available all day to the students.

ADVANTAGES

The major advantage is the proximity to activities in the classroom. Teachers can be involved with other groups of students and still have activities happening on the network. The computers become a part of the classroom and are seen as a regular activity like any other in-class activity. They are available as enrichment for students moving at a faster pace and can be used for remediation activities as needed.

DISADVANTAGES

The disadvantage to the distributed network is that the number, four to six, establishes an instructional pattern for the classroom. It is almost assured that a learning-activities center's approach will evolve with the computers being one center and students rotating through the centers. The number of students in each group is determined by the number of computers, and consequently, the number of centers is also determined. A typical pattern might be to have a center for computers, art, math, reading, writing, and science. Unfortunately, in this setting the technology

is dictating to the teacher both method and organization of the classroom. The equipment tends to become an end in itself rather than a means to learn basic curriculum skills.

Teachers often become absorbed in the group classroom activities or other groupings of students, and the equipment sits idle. The lack of need to schedule time for use also reduces the need to plan the system use into instruction within the classroom. The computers tend to become a nice adjunct, an enrichment to the classroom, but not essential. Obviously, there are teachers who are an exception and who have a strong commitment to continuous use.

Observation of Central Kitsap classrooms with the small cluster of computers also suggests these computers tend to get less use than in other configurations with larger concentrations of equipment.

Minilab Configuration

A somewhat more versatile distribution is in a minilab of approximately 15 computers. In this configuration a teacher can have half of a typical class working on the computers at one time. This makes for a practical rotation with the other half of the class and can provide at least some time each day for instruction with a reduced class size. Such rotated activities provide an economical technological solution to lowering class sizes for at least a part of the day.

ADVANTAGES

The minilab usually requires sharing among several classrooms and during times when all stations are not committed, smaller groups can rotate in for use. Thus center-type instruction is possible, but the size of the group is not dictated by the equipment as rigidly as it is in the in-class version. Scheduling is easier with only two or three teachers needing to work together to assure minimal conflicts.

DISADVANTAGES

The minilab requires a setting of its own and may present cost-effectiveness problems if staffing must be provided. Minilabs are most successful in settings where students are relatively self-

motivating and controlled and where several teachers have opportunity to observe the lab area. Schools constructed with common "pod" areas can effectively use this design. Some schools with appropriate hall configurations or with available small rooms that can be observed by teachers or other adults can also use this arrangement.

Class-Size Labs

The larger lab, typically with 32 computer stations, provides the opportunity for entire classes of students to use the lab together. From the teacher's perspective, it does not require multiple preparation and does allow monitoring of how students are doing while they are working on the computer. The concentration of students can allow economical hiring of a lab assistant to maintain the system a. ⁴ monitor the students.

ADVANTAGES

In a typical elementary school of 500 students, a single lab can be scheduled for each classroom half an hour every other day. Although this does not seem like a large block of time, it is at least 1 hour more than usual of interactive learning at the students' own pace. If a school were to attempt to provide the same schedule of interactive time using people one-on-one with students, it would take approximately 18 additional staff members. Such schedules maximize the use of the computer system, but the use is relatively rigid in the classroom schedule. Teachers must stick to the schedule to make it work.

At one level of use, the lab can provide self-paced instruction in most subject areas. Students have the opportunity to advance as rapidly as they are capable. As teachers become more familiar with the lab, they can choose to have all students together on a lesson relevant to classroom curriculum. The lab time can provide the teacher with information about how well students are understanding the concepts. Based on the results, subsequent instruction can be redesigned. The lab can be used for introduction of new concepts, practice on concepts, or as a means of evaluation of group performance.

As teachers learn to share the technology, patterns emerge of small groups being combined with other classes that do not require all stations. Teachers can split classes and send two half-classes to the lab allowing the teachers to teach to a reduced class size back in the classroom. The lab can provide a wider range of uses and more consistent use than smaller clusters of computers.

DISADVANTAGES

Although class-size labs provide flexibility, they can also cause rigid scheduling to occur. Unless teachers feel comfortable in allowing an individual student or small groups to go to the lab unattended, the student exposure to a lab becomes limited. It is also generally necessary to employ an aide to oversee the lab and its use. Also, when a class-size lab is down, all students lose access, not just a few.

Advanced Lab Designs

In schools committed to integrated learning systems, computer labs can be designed into clusters of five or six classrooms. Arranged so all rooms can access the lab and can be observed by the teachers, this concentration of computing power next to the classroom provides very high levels of use. Teachers can schedule their whole class for group instruction related to a curriculum topic available on the system, or they can design for smaller select groups to work on anything from word processing to concentrated practice on mathematics. There are always computers available for individual use. See Figure 7.1 for an example of this configuration.

Quantity Will Determine the Level of Integration

As long as technology remains separate, or highly limited in quantity, it can only remain as an adjunct to instruction rather than becoming an integrated and essential component. The free flow of students between the classroom and the technology allows it to become an integral part of instruction at any point in the day

and for any project. Although a 1:1 ratio of students to computers is ideal, many districts plan a 4:1 ratio.

Multimedia Production

Multimedia production capability needs to be geared to the level of use projected by teachers. Certainly, one system for the school provides the opportunity for some students to create presentations. If media presentations are to become more widespread and production of them by many students, the availability of other stations must be greater.

PROJECTING USE TIME

A minimum project time is in the neighborhood of 10 hours of work by a team of four. Although not all students may want the experience of producing multimedia, use should be projected in determining how many multimedia stations to buy. Are teachers who want to use it willing to allow students 10 hours away from the classroom? If there were enough stations for all students in a class to work in teams on a project, would enough teachers want to do it to make the investment worthwhile? These questions must be answered at each school site.

LOCATING MULTIMEDIA STATIONS

Location again can be a significant issue in use. Carts can allow equipment to be moved from classroom to classroom but may have drawbacks in terms of places within classrooms for use or difficulty in getting between rooms. Central locations such as libraries can provide concentrations of equipment but may require scheduling or create supervision issues. The best location is near other computers where adult supervision is available.

PURCHASING SCHEDULES

Multimedia equipment is ordinarily not linked as are large computer systems, and so it can be purchased over several years with a plan to eventually have a large enough concentration of

equipment so that entire classes can be involved in a project at the same time.

The critical mass of multimedia technology for widespread, commonplace use is probably five or six stations for an elementary school of 600 students. Secondary schools with strong vocational programs will often have double.

Video Production Technology

Video production is similar to multimedia in not requiring as many stations to provide adequate opportunity for students to use it as a learning tool. One high-quality well-equipped desktop editing system should be available at a school. Once familiar with the equipment, a 5-minute video can be edited in approximately 10 hours. Again, a determination needs to be made if this will be an experience for all students or for groups selected to use the technology based on some criteria.

BASIC EQUIPMENT REQUIREMENTS

Camcorders should be available at a ratio of at least four camcorders per editing desktop.

Video production requires significant time in scripting, making arrangements to videotape, taping, viewing and logging taped material, preparation for editing, editing, and duplication. Students need enough camcorders so that several groups can work simultaneously on videotaping. At least two other VCRs should be available so that a video can be viewed and logged without tying up the entire editing system. For this to work effectively, the counters on all equipment must count in the same units. Time units are easiest to work with. The additional VCRs that can also be used in other places should be available during the logging-of-tapes phase.

As students get older and video projects become more involved, more systems will be required to allow adequate access. High school students often find the medium intriguing, and numerous projects can be in production simultaneously. At Olympic High School in the Central Kitsap School district, combined pro-

jects between the Art and Science departments have resulted in four stations being available to the two departments. Student products from Olympic are regularly entered in competitions at state and national levels with rewarding results.

CD-ROM Databases

If information is only available on one computer in a school and students must schedule time or stand in line to use it, it is unlikely to become a fundamental tool for change in education. The stand-alone CD-ROM on a computer is tantalizing but too limited in access to make a serious change in instructional behavior.

MAKING THE INFORMATION AGE REAL

Putting a CD-ROM stacker on a networked system allows access from over 100 computer stations throughout a school to seven or eight major databases and begins to change how students learn. It makes the electronic age of information transfer real and helps students understand the need for analyzing data and creating new information products from several sources.

Quantity Makes a Difference

In all of the above technologies, quantity makes a difference in how the equipment will be used. Having too little is likely to leave it as an adjunct to learning and instruction. The result may be underutilization of the equipment. When technology becomes ubiquitous, the way in which learning occurs changes and a fundamentally different system of instruction begins to emerge.

How much is enough? It will depend largely on the instructional goals of the staff and the opportunity to consistently and reliably use the systems. Even if funding is not available in 1 year for everything people desire, formulate the long-range plan and implement it over several years. At some point, the availability of a "critical mass" of technology will begin to fundamentally change teaching and learning.

Ergonomics

Ergonomics refers to designing environments and operation of equipment for people. Although it does not sound overly difficult, several issues can create difficulty for administrators, teachers, and students.

Furniture

In schools the size of the customer varies greatly. The chair and computer desk that fit the sixth grader will leave the kindergartner's legs dangling and them reaching above their chin for the keyboard or mouse. The same is true at the secondary level. Easily adjustable computer furniture is more expensive and sometimes difficult to find. The using customer should be carefully considered in making plans for layout and furniture purchase. It is best to design a configuration that includes many sizes so students can be assigned one that most closely fits their needs.

If students are expected to spend significant time at the computer, consideration for angle of hands during keyboarding and ways to support the wrist or forearm should be taken into account. The effects of long hours at the keyboards improperly configured lead to industrial compensation complaints for a variety of hand or arm neurological conditions.

Lighting

Lighting and screen glare are other problems that will need to be addressed. A computer screen in direct sunlight is virtually unreadable. Even screens with glare resistance are uncomfortable to read if there is a bank of bright windows across the room. Each location will be different, but careful thought and attention can avoid uncomfortable mistakes. Take one or two pieces of the equipment to the location and have students try them out. Observe what may be uncomfortable.

Radiation

Consider issues of radiation with monitors. Some monitors are better than others. By attending to the radiation patterns from monitors, exposure can be minimized, especially in regard to sideways and back-directed radiation. Although harmful effects are still debated, the prudent course is to have considered the issue and used the best practice.

Using Processes to Develop Implementation Strategies

Technology is something one does *for* people, not something one does *to* people. The staff should be thought of as customers and should be carefully consulted to identify what their needs will be in implementation.

Scheduling Events

Scheduling of events is critical. Crews drilling holes in walls and running wire will be incompatible with many activities in a school but may be tolerable in some areas. Consulting staff about deadlines and installation timetables and the need to move classrooms and activities can help make the coming of technology more exciting and anticipated. Obviously, summer vacations are an excellent time for such work, but planning should make certain that stored materials or personal spaces are not overly disturbed. If they must be changed, people should be notified and given options to move materials. Offering teachers custodial or maintenance help in moving foster a more pleasant experience.

Planning Teams

Consider using a planning team for implementation to decide where technology will be installed and to help schedule it. At this point, it is easy to think only in terms of teacher convenience, but the final customers are students. Including students on the team

may provide some surprising insights and lead to installations that are better used.

Parents and community can also be assets, particularly if some of the parents are involved with technology on their jobs. Often their experience and insight can be helpful in avoiding errors or in maximizing how technology is laid out. Insights about wiring or lighting and reflection can be invaluable. Do not forget the custodian and someone from the central office maintenance department.

Installing and Bringing Technologies On-Line

Few administrators will have the expertise necessary to make all the right decisions about wiring a computer network in a building. Consistent with quality education identifying, a quality process and the right people to carry it out will most likely result in success.

If the school district does not have its own expert, employing a consultant will be necessary to provide design and construction assistance. Finding a few other people to help assess the consultant is appropriate. All consultants are not equal, and some will work better with a particular staff or situation. In one situation, after 2 hours of technical jargon about wide area network devices and wiring, the consultant left. All but two of the people in the room admitted they understood virtually nothing he had said. They said nothing because they were afraid others present did. This consultant was not invited back.

If there seem to be several options and the consultant does not satisfactorily address them all, a second opinion may be in order. If you are working with a group that includes parents, it may be that some of them will be more expert in assessing the consultant's opinion. Challenging the consultant to justify or explain his or her opinion or recommendation is always a good idea.

Being skeptical is a virtue. In all likelihood, the consultant is not an expert in school business any more than the typical school administrator is an expert in networking or computer technology.

Constant questions and explanations will improve the dialogue and over time either raise or lower the confidence level. How the product will be used in the instructional process should always drive decisions.

Use a General Contractor

Deming makes a strong point of having one vendor and sticking with him or her. One way to be more certain that all aspects of a system come together is to use a general contractor. The contractor then becomes responsible for coordination of all subcontracts and is responsible for making sure the system performs as specified. This removes coordination and compatibility issues from the school or district. The experience of the contractor can also help avoid costly errors or rework. Writing the performance contract to assure accountability is imperative. Look to districts who have experience in this area for advice.

Creative Solutions

In the Issaquah School District near Seattle, Washington, the presence of on-staff expertise has resulted in a program of hiring students during the summer to help with the physical part of wiring buildings. The student crews provide cost-effective labor and when properly supervised have been successful in installing the network designs.

Time Tested

Adequate time to test systems is essential to make sure they will work on the first day of school. Although we have seen systems successfully installed over the Labor Day weekend and staff trained on the day before classes begin, this is less than desirable. Such instant systems only work where limited networking is attempted with previously guaranteed compatible software.

Large local area networks (250 computers) running a variety of third party software need longer time lines. It is not unreasonable

to allot at least 3 weeks before school starts for technicians to test and assure operation of hardware and software. Some of this time can also be used for training. The training will provide further tests of the reliability of the system. Large networks often have peculiarities that need to be worked out by the technician.

Zero Downtime Goal

The goal is to have a usable system on the first day it is needed. If it works well and does not crash teachers will come to rely on it and plan for its use. If its early history is one of being down for days at a time, teachers will plan other activities and habits will form that see the system as peripheral rather than essential to instruction. Integrated learning systems used in conjunction with whole language activities can virtually replace the need for many sets of textbooks as long as the systems are functioning. If they are frequently down, it is tantamount to coming to school and finding all the pages of your textbooks glued together.

Reliability must be assured early in the operation before school opens or before the initiation date of the system. Build plenty of time into the time lines for testing of the system. No one has ever complained because a system was operational ahead of schedule and outperformed expectations.

Network Policies

Once a system is in place policies need to be developed to assure its consistent operation. Despite assurances of compatibility by software vendors, experience has often been otherwise. New incompatible software placed on an existing network can grind whole schools to a halt. The advantages of installing the latest and greatest software are quickly outweighed by the damage it does to the reliability to the system. Again, vacations are the only reasonably safe time for major software purchases to be added and tested on the system.

A written policy manual for all staff that spells out what can and cannot be done on the system is also important. On some networks, disconnecting and reattaching a computer in a different

location can wreak havoc. New untested software can crash systems. In one case the classroom pet rabbit who had the run of the room dined on the system wiring and brought the entire school to an electronic halt.

If staff understand the importance of having the system up and running and if they understand how the policies are meant to assure the operation, compliance will be relatively painless.

Training on New Technologies

Developing Formal Programs for Baseline Skills

Training and time for training are likely to become faculty themes as new technology is introduced. Establishing a faculty advisory group or using one of the groups created earlier can help lay out long-range plans.

Faculty as Customer

Again in the spirit of modeling the TQE concepts, the faculty is a customer. The administrator should be aware of what they indicate as needs and what they are ready for as the next step in training. It is easy to assume too much or too little. The trainer or manager may know what will eventually need to be taught, but it is better to merge that curriculum with the emerging one of the customer's growth.

Correct Technical Level

The greatest risk is for the trainer to be too technical. We recall making that error with a new faculty that was coming together around a new school and using a sophisticated local area network for the first time. At the end of the first meeting where the trainer began taking apart the back of the computer to show them the disk drives and central processing boards, several of the nontechnicals went home in tears. Some even requested transfers saying they just could not do that kind of thing. They did not need to. The

trainer failed to understand their needs and after some reflection focused on more important simple issues, such as how to turn the machine on and what commands got access to E-mail to send in lunch counts.

Just-in-Time Training, Just Enough

Experience suggests that about 4 hours of training are needed to get people ready to initially use a network. Training should be focused on the simple issues of turning on machines, booting systems, gaining access to software, and the information necessary to become a basic user of the most utilitarian software such as word processing. Foolproof ways out of the system and assurances that nothing will hurt the equipment and software are important up-front issues to be covered. Training in saving and filing information is essential to assure reduced frustration from loss of hours of work if errors are made or if the system fails. In-service training for using an ILS is more demanding but can be done over an expanded length of time. Training must also take place when the product is at hand and immediately before use is expected.

Take Computers Home for Noncritical Use

If a system is planned for fall use at the opening of school, the initial training can take place at the end of the previous school year. The computers can then be provided to staff to take home over the summer if they choose or they can be assured of a place to pick up a computer when they are ready to learn it. Time alone without the demands of production is a good way to learn to use word processing or a new computer. The opportunity to do some noneducational tasks, such as letters to the family, help teachers become comfortable and familiar with the equipment so that when they must tackle more complicated tasks they will be successful. Because basic questions are bound to arise, a sufficient user manual should be provided so that help is readily available. Identify someone who knows the programs and is willing to be called. If staff have no resources, it is likely they will encounter

frustration and simply give up. Retraining again in the fall just prior to its use is essential.

Lifelong Learning Community

Implementation of a new computer system is something of a leveler of all staff. Everyone is suddenly in the shoes of the learner: custodians, secretaries, principals, teachers, and students. The need to learn the system makes everyone lifelong learners and suddenly equal in their lack of information about this new addition to their environment. It can be a healthy time of honesty about what "I don't know" and a time when people can ask questions and assist each other. It is an opportunity to build camaraderie and help new staff members or students emerge as leaders and experts.

Formalizing training is still a must. The ability to advance in use of the system will depend on expanding understanding of how it works and how to get more service from it. Short, frequent sessions with time in between for experimentation are important.

Eliminate Fear

Back to Deming's cardinal rule: Drive out fear! The goal of implementing technology is to have people use it and feel comfortable with it. There are no dumb questions. People will need support and the sense of everyone working together to make the best use of a large capital investment. If the lives of teachers become easier and more rewarding, the technology will be used. If students learn faster or better, it will have fulfilled its promise. Few of those goals will be reached if people are afraid to ask questions or to try out a new teaching or learning strategy.

Align Performance Evaluation

Staff evaluation practices need to be aligned to the expectations to develop new programs. Few experiences are more discouraging or fear producing than to be working in a new environment

and trying to develop different methods of teaching only to be evaluated on topics such as "ability to lecture." Administrators have the obligation to assure alignment between the new environment and evaluation and recognition programs. This alignment is one more example of how all parts of a system must change to be successful. An old evaluation system sends a conflicting message regarding the seriousness for change.

Recognize Teamwork

Real success in a TQE environment will result in more teamwork and less individual recognition. As teamwork takes hold in a school district, it has been observed that more teams qualified for recognition and fewer individuals. Criteria for recognition had to be changed and aligned to match the emphasis on improvement based at a team level.

Using "Techies" to Support the Program

Every staff has one or two people with greater interest and ability in technology than the others. Nicknamed "techies" they are the natural resources for training and support. If their services cannot be institutionalized and supported with special stipends, other methods of recognition and support need to be found. Often they are willing to give their services for free, but at some personal cost in time. Rewards for their efforts can take the form of visits to other schools, planning days, conference attendance, or access to publications and support materials.

Techies' needs are different than those of the regular staff members. They already know many of the basics and are better used as teachers or resource people. Reward them with special equipment or programs and opportunities to explore technology in depth.

Institutionalizing technical services provides even greater levels of service. Figures 5.1 and 5.2 illustrate job performance descriptions for people who provide support for teachers and students.

The Technology Integration Specialist's (TIS) job is to assist with using the technology better in the classroom. This person

Technology Integration Specialist Position Description

This position is responsible for assisting teachers in learning how to integrate the use of technology into the instructional process.

Performance Responsibilities

1. Provides instruction to teachers and students in the use of instructional technology in classrooms.
2. Assists teachers in incorporating technology into short- and long-term instructional planning.
3. Provides assistance in using computer-assisted instruction.
4. Provides technical assistance, consultation, and training in the use of a variety of instructional technologies.
5. Assists in the development of instructional units for integration of technology into the curriculum.
6. Provides staff coordination in the use of technology to improve administrative functions of teaching.
7. Works with a wide variety of groups and people at various skill levels.
8. Serves on the District Technology Committee and chairs appropriate building technology committees.
9. Facilitates purchases from district technology funds allocated to the building.
10. Develops and maintains a software library appropriate to support building curricular needs. Inventory annually.
11. Works with District Technology Committee and Staff Technology Center staff to solve software and hardware problems related to instructional technologies.
12. Manages building inventory of hardware purchased with District Technology Committee funds.
13. Annually evaluates building's technology implementation and revises goals as needed.
14. Works cooperatively with other staff.
15. Performs similar, related duties as assigned.

Figure 5.1. Technology Integration Specialist Performance Responsibilities

Note. Courtesy of the Central Kitsap School District, Silverdale, Washington.

Technology Support Specialist Position Description

This position assists in operating and maintaining building Local Area Networks (LANs). The position schedules LAN use, makes computer program modifications, and assists teachers and students where appropriate. Additional responsibilities include troubleshooting of hardware/software problems with LANs and stand alone computer systems and assisting with generation of reports and diagnostic testing if appropriate.

Performance Responsibilities

1. Operates a LAN with a central processing unit and 130 or more stations. Performs all system backups. Maintains computer lab bulletin boards, displays, and materials related to technology and learning.
2. Develops knowledge of computer programs, network software, and curricula. Consults with certified staff and administration concerning student objectives and programs. Assists teacher in design and delivery of lessons that use computer software.
3. Prepares materials for lab use. Assists students with lessons. Maintains class and student records.
4. Monitors students' behavior in computer lab areas. Promotes a positive attitude toward learning. Communicates with teachers and administrators concerning disruptive students.
5. Generates reports as requested and according to schedules. Tailors reporting to specific needs of teachers.
6. Troubleshoots hardware and software problems and performs minor maintenance. Submits paperwork to request enhancements or problem correction. Works with Staff Technology Center (STC) staff to resolve hardware and software difficulties.

Figure 5.2. Technology Support Specialist Performance Responsibilities

Note. Courtesy of the Central Kitsap School District, Silverdale, Washington.

7. Provides orientation to new students regarding operation of equipment. Designs and presents training units for each curriculum at the beginning of each course. Assists administrators with program implementation presentations.
8. Coordinates, plans, and supervises Dynacom broadcast system and students who operate the system. System includes broadcast, student news program, title generator.
9. Works as a team with building Technology Integration Specialist (TIS).
10. Assists in training new staff members on use of the building LAN(s). Attends program-related staff meetings. Attends parent-teacher conferences to share information concerning students as requested.
11. As appropriate, assists with supervision of students. Listens to students' personal problems and provides guidance as appropriate. Is willing to attend technology training as appropriate.
12. Performs similar, related duties as assigned.

Figure 5.2. Continued

brings dual credentials to the job: he or she is 1) more highly trained in the technical systems and 2) a certificated teacher who is innovative in classroom practices. Assigned to two schools, the TIS is accessible to the teaching staff and facilitates the interface between technology and teaching.

Another person called the Technology Support Specialist (TSS) is there to see the equipment operates and to do minor repair. This includes loading and testing software. Also assigned to two schools, this position provides essential support to teachers. Finding the funding for those new positions came from phasing out less needed positions, previous stipends, and nonclassroom assignments designated for technology support. These positions will be described more fully under the discussion of Figure 6.1.

Vendor Training

Vendors also have people capable of providing assistance. Training can be included as a part of the purchasing contract in many cases. Most vendors are concerned for service after the sale and want customers to be satisfied. One should also check to see what kind of support is available after initial training. Do vendors have a support department? Will callers be put on hold for half an hour or are there adequate people available to help? Consistent with TQE, can the school have one vendor—a single person—who will be their contact for training needs?

Using Students to Train Each Other and Teachers

For some reason students seem more naturally at home around technology than are most adults. Whether that is due to the games they play at home, their lack of fear, or the amount of time they have available to experiment, students are an asset that should not be overlooked.

A regular program of using students as trainers can add to their self-esteem and rapidly expand the base for use of technology. In one instance, the school regularly trains a cadre of students in any new technology. That group, often 8 to 10 individuals, is responsible for training four more students or teachers in the technology. The new recruits in turn must train four more, and so on. Training quickly disseminates throughout the school, and the students benefit from their new and useful role.

Information Age Learners

Nontechie teachers are often reluctant to use the new technology because of the time it takes to learn to use it effectively. They may also feel inadequate because they perceive their students are much more knowledgeable than they are. These teachers must be helped to overcome this feeling and allow students to become "teachers," too. The new information world is likely to be one where lots of people have differing degrees of expertise about specific technology. The manager in industry can no longer know

all the details of the work that must be completed by the worker, and so it is with teaching: Students, teachers, and administrators are going to be involved in lifelong learning. Creating an environment in a school where students can meaningfully contribute to others' learning is a message about how the "real world" is beginning to function.

Using Partnerships and Volunteers

Schools whose outreach program to the community has included partnerships and volunteers can often locate excellent technical help for expanding the use of technology. Businesses that use the technology and people who pursue it as a hobby have much to offer students and teachers.

A series of partnerships between the U.S. Navy and the Central Kitsap School District paid off when a group of sailors came to the local high school to organize their computer writing lab and assist students with word processing programs. The volunteers spent several hours weekly supporting students as they learned how to make the best use of word processing for writing.

In another relationship, a group called Kitsap Computing Seniors wanted the retired adults and other community members to learn computer skills. They wanted to recruit and train other senior citizens so computers were not a mystery left only to the young. In exchange for time in one of the school computer labs in the evening, the seniors have installed modems and phone lines that can also be used by students and staff during the day. They also volunteer numerous hours working with students on computers and have made district resources available to several hundreds other senior citizens as they teach the basics of computer use. The public relations' value of this partnership is invaluable.

Staff Technology Training Center

Full-fledged support at a district level can result in a staff technology training center (STC). The Central Kitsap center has a demonstration local area network lab and can provide away-from-the-school concentrated blocks of time for training. Knowledgeable

trainers also serve as resource people for buildings to call and get quick answers to hardware and software problems. The STC can create cycles of training curriculum allowing users to advance in complexity on specific software programs. Such centers are useful for support staff who continually upgrade skills in word processing programs, databases, and spreadsheets.

Capitalizing on Imagination, Experimentation, and Play

Learning and training can be hard work or they can be more like play. Children learn a great deal about their world by playing. For some, computers and technology will be most meaningfully used if they can "play around with it for a while." The point of play is to not have too much at stake so one can learn and experiment. The teacher who decides to learn to use a camcorder by taking one home and filming the birthday party is much more likely to have a successful product when needed than the teacher with no experience. When the project is a serious one, for example, a video for the year-end Parent-Teacher Association (PTA) meeting, the time spent "playing around with the equipment" will pay off. People are more apt to experiment and learn if there is not a serious final product on the line. Administrators are wise to encourage those who learn by playing around to spend time learning technology in that fashion.

Training as a Never-Ending Process

This is the information age. The era of once-trained, always-trained experts is gone. Knowledge multiplies at an enormous rate, and the expectation should be to put in place cycles of continuous learning. Continuous improvement in TQE is linked to continuous learning. The sooner an organization internalizes the corporate culture of always learning, the sooner it can effectively improve. Technology and its effective application is tightly linked to the continuous improvement inherent in the quality education philosophy.

Key Terms and Concepts

Computer labs. Usually refers to a location with a collection of computers large enough for an entire class to use simultaneously.

Desktop editing. The ability to edit a videotape by using relatively simple equipment that is available in units that fit onto a single desktop. Often includes two editing VCRs, two monitors, an edit controller, and a special effects or mixing board.

Distributed computing. Usually refers to the practice of putting between one and five networked computers in individual classrooms throughout a school as opposed to collecting them in a lab.

Ergonomics. Study of how machinery and people can be made to work efficiently together. It often refers to the comfort and productivity available to people working on the equipment, such as computers.

Just-in-time training. Providing the right amount of training just before it is needed and can be used.

Minilabs. Collections of computers that typically allow half of a class (15 stations) to work simultaneously on a project.

Network policies. Written policy about what practices will and will not be allowed on a network. The objective is to prevent failures or misuse of the network.

Staff technology training center. A computer lab dedicated to staff use so that classes can be held on various uses of software or teaching techniques using technology.

Student trainers. Using students to train each other and teachers in the use of hardware or software.

Zero downtime. A network that operates continuously without crashing or becoming unusable at any time when staff or students need to use it.

✧ 6 ✧

Developing the Support Systems for Technology in Education

Support for technology takes the form of instructional support or hardware and software support. Economies can be achieved through district-level programs and employment of in-house technicians. Where district support is unavailable, outside vendors will have to be used to assure consistent operation. Support services should be based as closely to the consumers as possible and be made consumer sensitive. Figure 6.1 suggests a district-level service structure that can be sustained in medium-sized school districts.

The illustrated system takes an integrated approach to information systems and includes traditional library systems as an integral part of steadily advancing access to information through technology.

District-Level Support Structure

Technicians

Service in the illustrated model is delivered at the building level by having three regularly assigned staff members serving each building on a part-time basis. Each performs a different function. Technicians are noncertificated staff persons who have high technical skills in dealing with computer systems, hardware, software, and networks. They are capable of working with software problems at the programming level. Typically, they can service

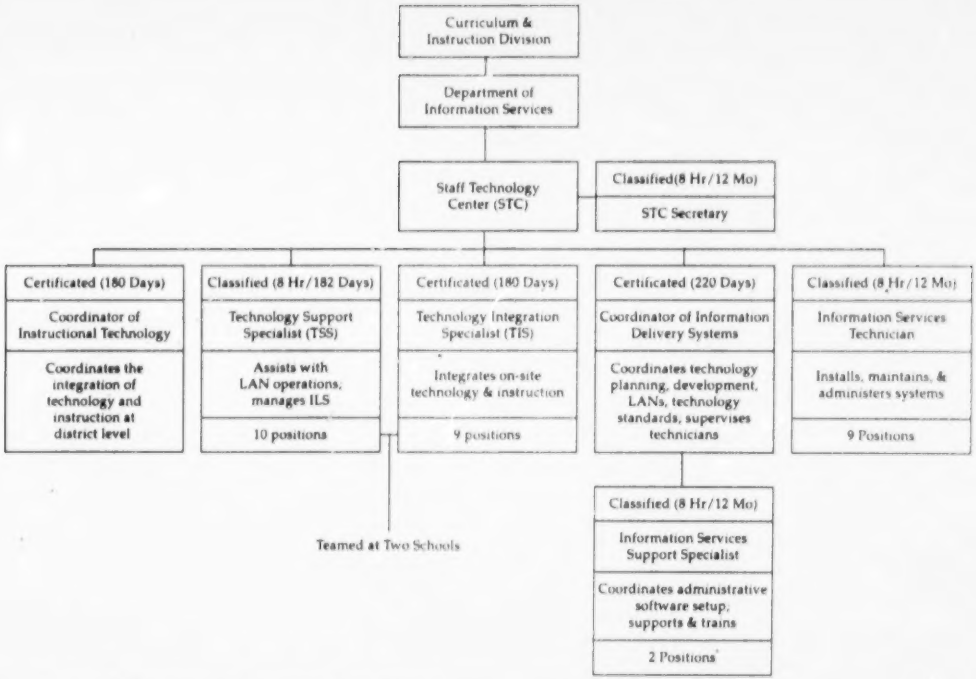
Curriculum & Instruction Division
Department of Information Services
Staff Technology Center (STC)
Classified(8 Hr/12 Mo)
STC Secretary
Certificated (180 Days)
Coordinator of Instructional Technology
Coordinates the integration of technology and instruction at district level
Classified (8 Hr/182 Days)
Technology Support Specialist (TSS)
Assists with LAN operations, manages ILS
10 positions
Certificated (180 Days)
Technology Integration Specialist (TIS)
Integrates on-site technology & instruction
9 positions
Certificated (220 Days)
Coordinator of Information Delivery Systems
Coordinates technology planning, development, LANs, technology standards, supervises technicians
Classified (8 Hr/12 Mo)
Information Services Technician
Installs, maintains, & administers systems
9 Positions
Teamed at Two Schools
Classified (8 Hr/12 Mo)
Information Services Support Specialist
Coordinates administrative software setup, supports & trains
2 Positions

Figure 6.1. Technology Organization Chart

Note: Courtesy of the Central Kitsap School District, Silverdale, Washington.

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three or four schools once systems are installed and working. During the start-up of systems, they will be nearly full-time on one system for its first few months of operation. Because programming and maintenance of systems have a "style," keeping the person working on the same system reduces familiarization time in solving networking problems.

Support Specialists

The other noncertificated persons, called Technology Support Specialists, are less technically skilled and are typically trained to the specific system by vendors or in-district training programs. Their responsibility is to keep the system operational at a nonprogramming level. Tasks are related to printing student reports, preparing systems for new classes, assisting teachers in their search for appropriate lessons, and having particular lessons ready for classes coming to a lab. Technology Support Specialists are sometimes called lab aides in that they are there to assure that the teachers' instructional goals are implemented on the technology. In the configuration illustrated in Figure 6.1, they are teamed with the certificated Technology Integration Specialist. Each person serves two schools on an alternating schedule determined by the customer needs. The teachers at the school are accustomed to having one or the other person available for consultations and assistance every day. See Figure 5.2 for performance responsibilities.

Integration Specialists

The Technology Integration Specialists are certificated teachers with special training in the application of software systems to instructional problems. As peers of teachers they provide consulting assistance and background on which software might best accomplish instructional objectives. They sometimes work directly with students or classes and bring extensive knowledge about the application of different software programs to teaching. They also assist with supporting teaching techniques such as whole language approaches that take better advantage of available technology. The Technology Integration Specialists are capable of conducting

in-service training regarding new software with the entire staff if desired. See Figure 5.1 for performance responsibilities.

Goal of Support Systems and TQE

Support systems must achieve two major goals: (a) consistent, reliable (no downtime) operation of technical systems and (b) expansion of instructional use of technology by students.

Reliability of Operation

If technology is at least as significant a learning tool as are textbooks and a library, it must be as reliable. Total quality management should be actively applied by the technical service departments in keeping accurate measurements of downtime and by frequently talking with customers about their needs. Systems should be benchmarked against each other, and process improvement techniques should be frequently applied to constantly seek more reliable operation and better service.

Expanding Instructional Use

Teachers are extremely busy people. Trying to learn and apply new methods of teaching is difficult and stressful during normal schooltime. The presence of specialized assistance, to shorten the search for appropriate tools and to help teachers learn enough about the software to be effective, increases their willingness to integrate technology into teaching methods. Expensive integrated learning systems must receive high levels of training in use to maximize educational return. The assistance provided by the specialists should be looked on as a normal expense of providing optimum payback for capital investment.

Building Level Support for Technology

District-level support for technology may not be available for administrators who are developing some of the first systems in a

district. Without the economies of district service departments, other means will have to be identified to accomplish similar objectives when technology is implemented. Generally, this expertise will come from attendance at seminars intended for business users.

Bid specifications for vendors are very important. Performance specifications help assure that systems work with all the intended software. Availability of service and training should be included in the specifications.

If district-level support cannot be obtained, a local school staff member can be offered stipends to become an expert on instructional assistance and fulfill a role of advising and assisting other teachers as they select new software and other instructional tools. This person should be someone who is trusted by other staff members and who is known for thoughtful use of a variety of instructional methods.

In addition, basic technical support can be obtained by changing a job description and by shifting duties of an existing person and applying this resource to the new technology.

Redefining Jobs, Reallocating Resources

Redefining jobs, roles, and resources is important as technology is brought on line. Technology should not be implemented as an add-on. The system of education is currently functioning near 100% of its limits or capacity. If technology is implemented, some other thing or service cannot be done in the system. It is important to identify what will be replaced and to make a commensurate reallocation of resources to support the new system.

For example, if the addition is a CD-ROM stacker with encyclopedias and other databases on it, there will be a decreased need for traditional printed encyclopedias. Purchase costs of the books can be applied to purchase costs of the CD-ROM system. Library aides' job descriptions must also change to assisting students and teachers with the new technology. Aides will have to be retrained to become more knowledgeable and competent in the use of this technology.

Preparing for Changing Job Descriptions

Effective implementation of technology should result in changes in how resources are applied. Changes in job descriptions can be volatile issues. Administrators should be prepared to make changes as attrition or personnel changes occur or to retrain people so they are comfortable accepting the differing job descriptions. Involvement of union leadership early in the process can help build a base for acceptance of change as long as the union's issues are also taken into account. Nothing can stall change like creating the perception that there will be fewer jobs or less importance to the jobs. Effective relationships and understanding of how the technical nature of jobs evolves can facilitate change and support for technology.

Technical Support

Establishing Vendor Relationships

Effective purchasing of technology is the first step to supporting reliable technology. TQM guru W. Edwards Deming makes clear that low-bid purchasing is a means to undermine quality. He argues for a long-term relationship between supplier and customer. The customer continues throughout the relationship to make known the needs for quality in the product (Walton, 1986).

Before purchase, bid specification should be carefully researched. When successful schools are visited, ask for a copy of their bid specification for their system. Some school districts will sell their bid specification, others will share for free. Some vendors, foreseeing large purchases and discounts for quantity, will allow related purchasers to join on the same bid. In some cases, after bids have been awarded and an operation is dependent on specific equipment, single-source bidding is allowed. The "best deal for the taxpayer" is the idea, and the lowest price is not always that. Keep in mind as bids are designed that one should always look for a combination of quality and service and low price.

Remember to write product support specifications into the bid, especially if the district does not have a strong service department. Vendors will often provide in-service training and telephone technical support if it is clear that is required in the bid. In some cases, negotiating a vendor technician at the lab site for a period of time can assure smooth operation at the beginning.

Students as Technicians

One secret maintenance weapon is students, even, or especially, at the elementary level! At Silver Ridge Elementary in Silverdale, Washington, "meaningful work" for students are watchwords, and some students with the toughest discipline problems have been turned into the youngest computer technicians in the business. Computers require routine maintenance, like cleaning and servicing keyboards. Principal B. J. Wise decided that routine maintenance was an important job that students who were regularly a disciplinary problem could earn with good behavior. With cooperation from the district technician, she set up a regular program of allowing problem students to learn how to service computers and then regularly work on maintaining the 250 computers in the school. Computer maintenance costs are down, discipline is up, system performance is up, and best of all, so is student self-esteem. Students are really making a contribution.

Maintenance Contracts and Hourly Repairs

Depending on the district repair capabilities, a decision will need to be made about maintenance contracts or simply calling in technicians on an hourly basis. Experience of local purchasing agents and other users of like systems can provide guidance in making the right decision. Whatever the choice, accurate record keeping will allow subsequent analysis of the decision based on actual repair and maintenance records. Keep track of breakdowns, causes, and costs. Involvement of the committees that helped select the system can assist with means to keep it operational. Not all maintenance or breakdowns are the fault of the equipment.

Insight in how to train personnel and how to prevent problems can be a major source of cost savings.

Maintenance and Software Updates

For integrated learning systems and some of the complex local area networks, vendors will offer regular upgrade packages that keep software state-of-the-art. If your vendor has a strong research and development department, the upgrade costs may be well worth the expenditures. Work to develop a relationship where input from your staff about weaknesses and desired improvements of the software will be forwarded to the research and development departments of your vendor.

Key Terms and Concepts

Maintenance contracts. Contracts with service firms to provide maintenance at a specific rate or for an overall fee up to a specified number of hours.

Technicians. Here, specifically references people whose job is technical in nature to assure operation of the hardware and software on a network available in a school.

Technology integration specialists. Here, specifically references staff members with a teaching certificate whose full-time job it is to help other teachers become more proficient at the use of software and computer systems.

Technology support specialists. Here, specifically references staff members who do not have a teaching certificate and support the operation of a network or a lab.

Reference

Walton, M. (1986). *The Deming management method.* New York: G. P. Putnam.

✧ 7 ✧

Considerations for Designing Technology-Based Schools for the Next Century

The opportunity to remodel or create a new school presents the best opportunities to integrate technology into instruction. Full-scale systems can often be included in capital costs and thereby kept out of operating budgets. At least the infrastructure (e.g., wiring and electrical service) can be included in the design. Again a TQE-focused process will most likely yield good results.

Processes for Envisioning Future Structures

If significant change is considered for a new building or for a remodel, it is important to include the community at the initiation stage of the process. Expectations for new schools are often highly traditional. Everyone went to school and, usually, everyone has a strong image of how it should look. Working with the community at the beginning of the process can save shock and outrage if a substantially different configuration evolves in planning.

Establishing a Planning Seminar-Committee

Membership in the planning group should be open so that anyone who feels he or she has a stake in the new building can be

a part. The process should affirm that input is better given early than late. Administrators are usually aware of staff, community members, and others who will want to contribute to the process. They can be personally invited as a means of assuring consideration of all points of view and developing a core of known workers.

The superintendent, the principal, or the board may develop a "charge" to the committee that they are to fulfill. Such a charge should define their role as advisory and help the members know just how much influence they will have in the final decisions.

A Learning Committee

For a truly functional design to emerge, the committee members will need to learn a great deal about technology, teaching, and building design. For that reason, such a committee may be called a "seminar" committee. In several cases, a college course was designed related to such a committee. Teachers participating in the committee earned credit toward degrees or for advancement on salary schedules.

Participation on the committee can be required as a prerequisite to applying to be a teacher in the new building. Arrangements need to be developed with unions that the "senior, most qualified" be interpreted to include participation in the educational specification and design phase for the new building as a requisite for selection to the staff. This arrangement is in the interest of employees and unions. Everyone stands to lose when a teacher who does not want to change is assigned to a faculty eager for change.

Common Experiences

As leaders of the committee, administrative staff should identify some core experiences everyone should have as a means of coming to common vocabulary and basis of thought. Processes such as establishing a mission and understanding core beliefs, values, and knowledge are valuable to give the committee direction. Those experiences might be videotape presentations such as Joel Barker's in which he stimulates thought about change with

discussions of paradigm shifts (Barker, 1984). Consultants could share educational innovation in other settings. In one instance, the Central Kitsap School District required the participating architectural firms to hire an educational futurist as a consultant in the same way it would hire consultants for value engineering. The consultants from several projects were pooled, and staff and community were invited to a stimulating 2-day kickoff seminar.

Travel to other school sites and discussions with people and architects who have recently finished innovative designs also help.

Readings

Reading will probably be the core of developing the committee's background. Selected materials should be provided. A way should be developed for participants to identify relevant research they wish to have considered. Means for members to submit articles for copying and distribution will streamline the process. Time to discuss the new and different ideas should be included on the agenda for every meeting.

Subgroups

As the topics become more complex, it may be wise to develop a series of subgroups to research and look into areas of special interest. A steering committee composed of the chairs of the subgroups can keep track of the direction of each group and assure that none get sidetracked into unproductive or duplicative work. The steering committee can also coordinate topics so that if consideration of one idea will have implications in another area, the appropriate committee can consider and research it.

Defining the Instructional Program

The second major phase after education and research will be defining the instructional program. The following are some potential questions to be answered in this phase:

- What will be taught?
- How should it be learned?

- How will students be grouped?
- What instructional delivery systems will be used?
- What technology will be used?
- How will information resources be made available?
- How can technology be configured for maximum access?

Architect's Role

During the preparation of educational specifications, the architect should be a major participant primarily as a resource and in a listening role, collecting the ideas brought forth by committee members.

As the project transitions to design, the architect is responsible for translating the ideas of the committee into reality. If members of the staff have been selected, by this time the designs can be critiqued from their standpoint and a dialogue begun to create the most educationally sound building possible.

Using Technology to Experience the New School Before Ground is Broken

The development of computer-assisted drafting programs can create a simplified version of virtual reality for planning committees. After establishing a basic design, the computer can create perspective drawings of the interior that allow the committee to walk through the building before the first shovelful of dirt is turned. The computer design capabilities also allow a child's-eye view of the building and can assure the aesthetics of the spaces as well as allow people to experience the areas set aside for technology and instruction.

Emerging Trends

Having reached the third generation of technology-oriented schools, some trends emerge as having proved workable and having maximized the use of technology. Probably, the most

important lesson is to cluster technology: Creating multiple computer labs within a school of at least 30 computers each and then surrounding them with five or six classrooms seems to give the greatest access. The arrangement allows for a free flow of students from the classroom to the lab and back. Teachers provide visual supervision without having to leave the class areas.

Award-Winning Design

Figure 7.1 shows the award-winning design of the instructional delivery component of Silver Ridge Elementary School in Silverdale, Washington. Designed by Tsang Associates of Tacoma, Washington, with the full involvement of the staff, the floor plan allows for implementation of the TQE process discussed earlier in this book. Note the banks of 30+ computers identified on the design document. The provision to relocate computers to the classroom was included in the design, but this rarely happens because it is easier to have the student move. With class size averaging 25, there are always spare computers for individual or small group work even when a whole class uses the lab.

Multimedia stations and other less plentiful technology should be available in each cluster as well. The library should contain research computers and storage for software and single-item hardware. The downlink for distance learning should come into the library for distribution throughout the building. In a building equipped with fiber optics, the library becomes the distribution source for much interactive instructional software. Space for this function needs careful planning, and its design should come from a practicing expert in this field.

Although the design of a school will not in itself assure a technology-enriched instructional program, a technology-hostile environment will make it impossible. Involving staff and community in the design process gains commitment to and acceptance of change from the onset. Six months for an elementary school and 8 months for a secondary school is approximately the time needed to plan a transformed, technology-rich school.

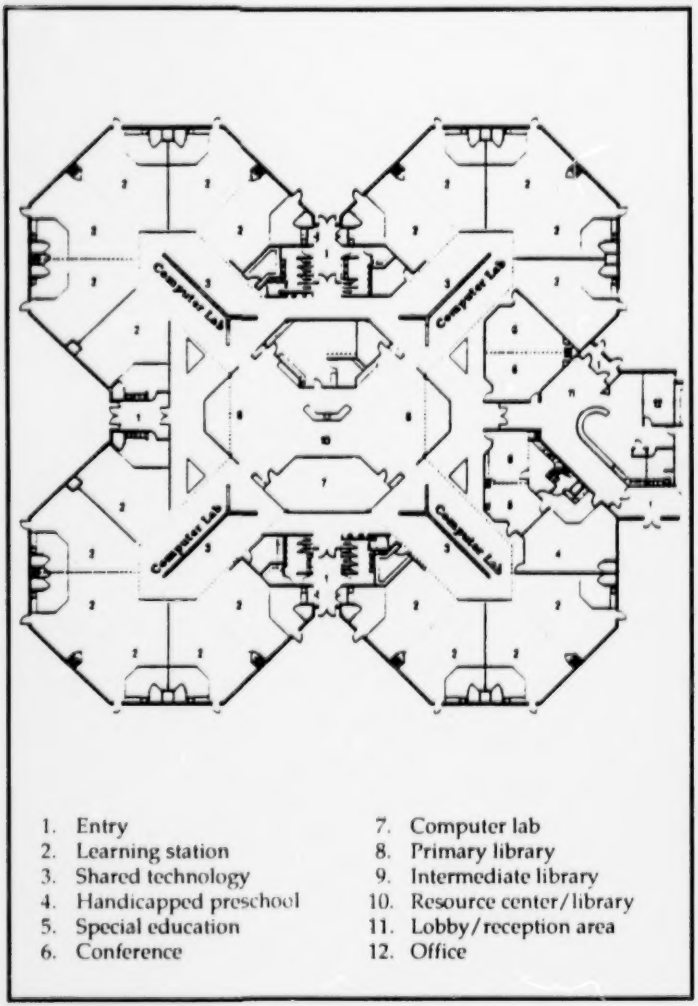

Figure 7.1. Silver Ridge Elementary School Pod Areas

Note. Courtesy of the Central Kitsap School District, Silverdale, Washington.

It will take the architect another 4 to 8 months to complete the working drawing. During this phase and the construction of the building, the staff should be involved in an in-service program to determine the instructional program and how the learning environment will be arranged. It is important to keep the parents involved during this time as well. Customer-information services should be planned so there are no surprises when the school opens. At the secondary level, students should be active players, too.

In summary, allow plenty of time for the design of a new building; use the process for creating the need and a commitment to change. Make sure the instructional program drives the building design and that as much technology as possible is part of the basic bid and not just a desirable alternate. Flexibility is a key word and it should influence both design and the instructional program.

Key Terms and Concepts

Planning seminar-committee. A committee that is simultaneously learning about a topic and planning a school. Each person becomes a learner and contributor to the process.

Reference

Barker, J. (1984). *Videotape: Discovering the future.* St. Paul, MN: Infinity Limited.

✧ 8 ✧

Developing Visions of "New Work Platforms"

In a recent commercial for Chrysler Corporation, Lee Iacocca stands in front of an old factory. Suddenly, it is dynamited and crumbles to the ground. Iacocca makes the point that when Chrysler adopted TQM, all the traditional ways of doing things came to an end.

The companies that have been most successful with TQM have often found that it profoundly changed the structure of how they did business. The insights for higher performance often came from the workers, and the final results were what has been termed *new work platforms*.

In the present educational system, the work platform has been the classroom. Does it need to be? Is there a more efficient platform for learning? How does technology play a role?

As of yet the new platform has not totally evolved and been tried, but it is challenging to take a moment and think where technology and the willingness to change might take education in the future.

What Skills Will We Need in the Future?

It is interesting to present a choice to parents, for example, "Your child can learn either longhand or keyboarding but will not be allowed to learn both. What do you think will do them the most

good in the workplace of tomorrow?" Keyboarding wins in most informal polls. Questions such as, "How much time should be spent practicing and perfecting arithmetic calculation when most people will use calculators?" are intriguing to discuss. Given the rapid spread of word processing equipment with spell checkers, "What is the correct amount of spelling to teach, and how much should be spent on remediation?" also raises the temperature of debate.

There is little doubt that technology has already changed the educators' world, and all are only trying to keep up. As the answers to the above questions emerge, changes for schools could be profound depending on what demands society places on education.

Industrialists now tell educators that very few projects are completed by individuals. Teams and teamwork are the formula for success in the next generation. Tasks are too complex for successful individual effort; the time lines are too short. What are the implications for schools? Will we keep children learning alone in competition with each other, evaluated only as individuals? Will it be the last time in their life their success is solely based on their singular effort? Will they learn the communications skills necessary for successful teamwork?

What does the information age mean for education? With knowledge exploding in ever-shortening doublings of information, how can anyone know enough to be an expert generalist? Will teachers become guides to information sources rather than the final authority on information? In the information society, will the skills of finding raw data and attaching meaning to them be among the most highly valued skills?

Can we avoid global competitiveness for our children, or will they have to have an education that makes them as attractive a workforce as students in Japan or Germany? Will corporations increasingly make decisions about where to locate based on the availability of highly educated, highly trained workforces? What will be the significant edge American children have in order to attract high-skilled, high-paid jobs to their community?

Criticism of schools is related to quality. The customers of students' education, the employers, frequently complain about the quality of the product students bring from school. Can TQE be

used with students to begin to address the quality issues our customers seem so unhappy about? Would application of TQE at the student level actually be able to improve the quality of education with which they leave school?

The questions are posed to stimulate answers that look at reform of schools and to consider the possibility of truly different work platforms that might result from applications of technology and quality management.

Changing Values for the Future Work Platform

What would a school look like that focused its work platform on the workers or students rather than on the managers, the teachers? Classrooms are convenient for the teacher, but are they necessarily the most effective learning setting for the student?

A vision emerges of a school organized by teams of students who are taught how to work effectively as a team. They are engaged in quality education processes to produce effective performance for the team. Access to information systems in the form of technology becomes increasingly important. Teachers might deliver services to the teams rather than students moving to the teacher. The boundaries of classrooms may be less meaningful than the ability of the team to access resources in the form of computer labs, science labs, art labs, writing labs, and other information resources.

Such a setting places much more responsibility on students for their own learning and requires evaluation systems with high levels of accountability to assure performance. The more immediate the feedback and accountability, the more likely the students can adjust learning processes to assure performance. Technology would be a key tool in such a system to assure rapid feedback and adjustment of process to assure quality.

Design of the educational product would take the form of essential learnings each student was expected to master. An effective curriculum would serve as a blueprint for the outcomes to be pursued in order to master each concept or learning. The blueprint would be developed with the careful input from customers such as employers, parents, and postsecondary institutions.

Follow-up studies of graduates would form a major evaluation tool of the system. Within the system, feedback would be provided by the next customer of the students' education. Feedback would be used to adjust curriculum and practices to assure the performance of students.

Failure would be virtually unknown; lack of performance would be translated into adopting different processes for learning until successful.

Technology would be made available in homes through modems and cable television. Data, lessons, and tutorials could be accessed from any home with a telephone. Parents could access student performance records from home. Voice mail systems would allow messaging between parents and staff.

The distinction between home and school as a learning environment could become increasingly blurred with the advent of increasingly accessible technology.

Delivery of information to any place in the world may argue for more small, day-care-like schools built as adjuncts to homes within the community and serving as few as 20 students economically. The technology could provide access to nearly all the information resources and expertise currently housed in more expensive, less personal schools. The overhead on such operations would be negligible compared to the costs of schools and could provide alternatives to construction and operations that are becoming increasingly expensive.

The vision may be somewhat fanciful, but it suggests that the evolution of schools is yet to be completed.

The exercise of imagining what schools can be is often a good starting place for faculties or work groups to begin thinking about the direction that can be taken to advance schools. The exercise provides vision and stimulates thought about changing practices.

Increasingly, schools are called on to have a vision of what is possible 10 and 15 years into the future. They are expected to be the agents for preparing students for the constant change they are expected to find in their lives. What was good enough for the old days is at best incomplete for the demands of the future.

Creating visions of the future and matching them with quality management principles and practices will provide the vision and inspiration to constantly seek improvement in educating children.

✧ 9 ✧

Checklists

No how-to-do-it book can be complete without checklists or specific process questions to be asked. Although this has occurred in other chapters, the three most important features in planning for and using technology deserve an in-depth examination. Process is not always an end in itself, but the success or failure of many innovative ideas has been thwarted by lack of attention to it. Likewise, the selection of an integrated learning system is crucial to a school, not only for its role in the delivery of instruction but also because of its cost.

Assuring the Development of a Successful Process for Decision Making

1. Create an invitation list.
2. Hold general open meetings of all interested people.
3. Establish the need for change.
4. Examine your beliefs and/or values about students and education.
5. Create a mission statement.
6. Develop a strategic plan.
7. Select a steering committee to guide process.
8. Establish time lines.

9. Organize study committees.
   a. Research the literature.
   b. Visit other schools.
   c. Use focused consultants.
10. Develop a vision of what you want.
11. Develop a system for sharing information and/or progress with
    a. Everyone who may be affected.
    b. The community.
    c. Decision makers.
12. Create a consistent format for committee reports.
13. Develop a network for sharing report and/or feedback.
14. Write a final document (have one person as major author to assure consistency in writing style) and include
    a. An executive summary.
    b. Implementation of time lines.
    c. In-service needs.
    d. Personnel implications.
    e. Budget impact.
15. Solicit recommendations for adoption from various committee groups.
16. Seek school board approval and support.

Selecting New Technology

1. What are the possibilities of networking with other systems?
2. Will the system be adaptable to new developments in technology?
3. Is there a plan to systematically evaluate the new technology? What are the residual costs?
4. Are new moneys expected or is setting new priorities in order?
5. How will the new technology be maintained? In-district technicians or contracted services? Will new money be needed? If so, is this money included in the budget request?

6. Are personnel needed to implement the new technology? Are these personnel temporary or permanent? Are these costs included in the proposed budget?
7. What type of support is offered by the manufacturer or supplier? Is there a cost for this?
8. What are the life cycle costs of the new technology? What plan is there for upgrades and replacement?
9. Does the new technology require any special environmental adaptations? If so, are these included in the projected costs?
10. What is the plan to communicate to staff and community the functions of the new technology?
11. Is there a time line for implementation of the new technology?
12. Is the issue of equity in schools addressed?

Choosing the Right Integrated Learning System

Following is an integrated learning system decision-making process from a district perspective (Hertzke, 1993):

1. Inform the school board of the desire to investigate the addition of an ILS to the district and receive their concurrence to move ahead.
2. Appoint one person to spearhead the ILS selection process. This person may or may not be an administrator. Have that person detail the selection process and the time line to be followed.
3. Require broad staff and community involvement.
4. Require the recommendations to address the following points:
   a. Identify the district's unmet instructional needs.
   b. Identify how the ILS courseware presents solutions to those needs.
   c. Determine the outcomes expected to be achieved through the use of an ILS. Are they higher test scores? More

individualized instruction? Less work for the teachers? Replacement of a textbook? Other outcomes?

d. Determine how the ILS will correlate with the district textbooks or the system of student learning outcomes.
e. Ascertain whether the ILS management system gives the teacher sufficient information to make instructional decisions for individual students.
f. Determine how student assessment is approached and whether students are automatically recycled, reinforced, or moved ahead.
g. Determine the hardware and networking configuration that best meets both the short- and long-term needs.
h. Identify the training and support needs. What support for the ILS is available from the vendor? For technical assistance? For financing? Is there a time line for installation and training of staff? What costs are the district's and which are the vendor's?
i. Determine the financial impact of the ILS adoption, including both first-year and life cycle costs, personnel costs, residual costs, and long-range replacement costs.

5. Schedule a visitation for you, the board, and other key staff to an established ILS site.
6. Competitively bid the hardware and network. Writing the bid specifications must be done with utmost care.
7. Request periodic program reports to the superintendent and the board and require a year-end evaluation. Request data in addition to achievement test scores, that is, student and teacher satisfaction, changes in teacher behavior, time spent on direct instruction, and so on.

Key Questions and/or Process Checklist

1. Has the issue or question be properly framed?
2. Are the right people involved? Have the right people been invited? Is the process open to others who believe they need to be involved?

3. Are community members involved? How can they play a useful role?
4. Can students be involved?
5. Is there a process for the group to follow that will lead to quality outcomes?
6. Is the group being given a mission or are they to develop their own mission?
7. What is the charge to the group? Who will give the parameters under which the group will work?
8. Has enough time been identified to properly accomplish the committee's mission?
9. Have measurements of the outcomes been devised or can they be?
10. Can measures of the outcome be used as feedback to modify process?
11. Are there benchmarks that target outcomes for the group? Can they be developed?

Reference

Hertzke, E. (1993). Computer-based integrated learning systems. In G. Bailey (Ed.), *The administrator's role in adopting and using integrated learning systems* (pp. 103-108). Englewood Cliffs, NJ: Educational Technology Publications.

✧ 10 ✧

The Look and Feel of Successful Reform

Numbers and formal evaluation are important aspects of any effort at continuous quality improvement and implementation of technology, but they are not the only measures nor may they be the most important ones.

If the measures are purely traditional and developed to measure a system whose outcomes may have been designed for another era, the measures may not be appropriate.

One school with an integrated learning system used the system heavily in its mathematics program. The software emphasized problem-solving skills and estimation. It operated interactively and prompted students to develop strategies for solving a variety of real-world math problems. However, when the students were tested on calculation skills on a traditional test, their scores were well below expectations. The traditional test matched speed and calculation ability and required solving pages of multiple column addition and subtraction problems. The traditional instruction, which would have included handing out ditto sheets of math problems and having competitions to see who could finish the calculations first or do the most in a limited time, would have been appropriate training for the test. But, would it be appropriate training for the way in which students will be required to use mathematics in the future? The school decided that the approach adopted on the integrated learning system made more sense for their vision of the future math needs of their students. They

matched their vision to the technology that helped them achieve problem solving and skills important to using calculators (the students did score quite highly on the problem-solving portion of the test). They then allowed themselves to be evaluated in terms for which the students were not prepared. Even the difference between monitor screen presentation and paper calculation can cause difficulty for the children. Traditional test score numbers alone did not adequately tell the story.

Changes in Student Involvement

As one watches schools undergo changes to technology and the other shifts to whole language approaches, team learning, and high levels of integration of technology, one observes a profound change in the quality and nature of student involvement with learning. Gone are the bored, lackadaisical, daydreamy faces, with teachers lecturing from the front of the room. Present are students talking in groups and solving problems, students working at their own pace and being challenged, and students engaged with real-world problems and feeling their worth as contributors to information.

These things are quite observable but not as easily quantifiable. The application of quality management principles in industry is often applauded with comments such as, "The workers are happier," "They like to come to work," "People aren't working against the system but are really trying to change it," and so on. These are legitimate evaluations that make hardheaded, bottom-line, business people advocates for.

As educators who are in a real "people business," we should not be embarrassed to note that "the students are happier, more engaged," or that "teachers have more time for working with small groups and spend less time correcting papers," or that "the staff is more positive and empowered to make decisions about their school." These are real evaluative data. They may be every bit as important as a traditional test score and they may lead us to some important, albeit intuitive, improvements in the system.

Preparing for Advanced Users

Defense contractors who are developing command and control systems use the term *evolutionary acquisition* to describe a process where the requirements of a system change during the time it takes to write the specifications and create it. It is a way of saying that what we want is really a moving target that will change regularly as we work toward it.

Such an understanding is important as we develop technology systems in schools. Until people begin to experience technology, it is difficult to know exactly how they will want to use it and what it will mean. As people begin to use it, the specifications (what they need it to do) are likely to change on a fairly regular basis. Being able to continually update and review the demands placed on technology systems will allow continuous improvement to occur.

The first year one of the more advanced technological schools used their system, they reported that they could have accomplished their goals in spite of the system. In the second year, they indicated they could not accomplish their goals without the system. By the third year, they were reporting they were accomplishing their goals because of the system. The system remained basically the same but with capacity to grow and meet the ever-changing demands placed by increasingly demanding specifications from faculty.

Adjusting for Problems

One could write another "what if" book about what can go wrong, but it really is not necessary if the basic steps have been followed in setting up systems and involving the community, staff, and students. Ownership for the technology should be shared. Through the use of TQE techniques, problem solving should be institutionalized in the school. When something goes wrong, it is only a matter of switching into the problem-solving modes.

Blaming people gets nowhere and should be unnecessary if proper selection and installation procedures of technology have

been followed. No system and no change will be without minor problems. The key is to create a culture that believes problems are normal and that people have the tools to solve the problems.

Share the initiation of change. Share the development of goals. Share the implementation of plans. Share the problem solving inherent in new ways of thinking. Share the credit for success.

Indicators of Success

The true driver of success in any TQE system is the customer. The final indicator of success is customer satisfaction. Administrators and staffs who undertake change should define success in terms of feedback from the customer or meeting a benchmark of performance. Predetermine the measures and use them to make decisions. When success happens, take time to celebrate.

As one of the direct consumers of services, students are the most immediate customers. Their approval is often most apparent by their involvement in school activities, their engagement in learning, and the joy and happiness they express in classrooms.

There are many formal measures, ranging from opinion polls to attendance records, that can indicate their approval. There is also a direct, intuitive feel about happy children that should permeate their environment. Watch for their reaction as one of the best benchmarks of success.

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TQE, Technology, and Teaching

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Personalized instruction has remained an elusive quest for educators for years, and computers have seldom lived up to their promise of individualized instruction. Now, however, technology and teaching *can* work hand in hand within the framework of *Total Quality Education* (TQE). TQE makes it possible to break through the system's current limits to create fundamentally different ways of educating.

Nationally recognized for their expertise in technology and TQE, Gene Hertzke and Warren Olson offer you a total "how-to" approach to the use of technology. They include the types of systems, hardware, and software available. You receive guidelines for determining how to match specific systems and needs, as well as strategies for implementing technology and TQE to improve teaching.

Given the problem of inertia in many school settings, Hertzke and Olson provide advice for overcoming resistance to change and caution you about the potential pitfalls. The authors make it clear that technology by itself does not work miracles; only people can do that. Your success is made easier with their helpful list of methods and structures that have proven successful in other schools.

For educators and administrators who want the best for their students, and who are willing to shatter old patterns to get it, ***TQE, Technology, and Teaching*** is your indispensable, step-by-step guide to the future.

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